Entomological Society of
Ontario
Proceedings
v.50

Ontario Department of Agriculture

Fiftieth Annual Report

OF THE

Entomological Society

OF ONTARIO

1919

PRINTED BY ORDER OF

THE LEGISLATIVE ASSEMBLY OF ONTARIO

TORONTO:
Printed by A. T. WILGRESS, Printer to the King's Most Excellent Majesty
1920

Ontario Department of Agriculture

Fiftieth Annual Report

OF THE

Entomological Society

OF ONTARIO

1919

PRINTED BY ORDER OF
THE LEGISLATIVE ASSEMBLY OF ONTARIO

TORONTO:
Printed by A. T. WILGRESS, Printer to the King's Most Excellent Majesty
1920

Printed by
THE RYERSON PRESS

To His Honour, LIONEL H. CLARKE,
Lieutenant-Governor of the Province of Ontario.

MAY IT PLEASE YOUR HONOUR:

I have the honour to present herewith for your consideration, the Report of the Entomological Society for 1919.

Respectfully submitted,

MANNING W. DOHERTY,
Minister of Agriculture.

Toronto, 1920.

CONTENTS

Entomological Society of Ontario

OFFICERS FOR 1919-1920

President—Mr. Arthur Gibson, Entomological Branch, Dept. of Agriculture, Ottawa.

Vice-President—Mr. F. J. A. Morris, M.A., Peterborough.

Secretary-Treasurer—Mr. A. W. Baker, B.S.A., Lecturer in Entomology, O. A. College, Guelph.

Curator—Captain G. J. Spencer, B.S.A., O. A. College, Guelph.

Librarian—Rev. Prof. C. J. S. Bethune, M.A., D.C.L., F.R.S.C., Professor of Entomology and Zoology, O. A. College, Guelph.

Directors—Division No 1, Mr. J. M. Swaine, Entomological Branch, Dept. of Agriculture, Ottawa; Division No. 2, Mr. C. E. Grant, Orillia; Division No. 3, Dr. A. Cosens, Toronto; Division No. 4, Mr. F. J. A. Morris, Peterborough; Division No. 5, Mr. J. W. Noble, Essex; Division No. 6, Mr. J. F. Hudson, Strathroy; Division No. 7, Mr. W. A. Ross, Vineland Station.

Directors (ex-Presidents of the Society)—Rev. Prof. C. J. S. Bethune, M.A., D.C.L. F.R.S.C., Guelph; Prof. John Dearness, Vice-Principal, Normal School, London; Rev. Thomas W. Fyles, D.C.L., F.L.S., Ottawa; Prof. Wm. Lochhead, B.A., M.S., Macdonald College, Que.; John D. Evans, C.E., Trenton; Prof. E. M. Walker, B.A., M.B., F.R.S.C., University of Toronto; C. Gordon Hewitt, D.Sc., F.R.S.C., Dominion Entomologist, Ottawa; Mr. Albert F. Winn, Westmount, Que.; Prof. Lawson Caesar, M.A., B.S.A., O. A. College, Guelph.

Editor of "The Canadian Entomologist"—Prof. E. M. Walker, Toronto.

Delegate to the Royal Society of Canada—The President.

FINANCIAL STATEMENT

For the year ending October 31st, 1919

Receipts.		*Expenditures.*	
Cash on hand, 1917-18	$57 28	Expense	$25 50
Advertisements	46 00	Printing	1550 07
Back Numbers	192 10	Annual meeting	105 65
Members' Dues	124 40	Annual Report	25 00
Subscriptions	470 11	Salary	100 00
Bank Interest	2 64	Library	3 50
Government Grant	1000 00	Cash on hand	82 81
	$1892 53		$1892 53

To balance due on printing	$230 81
By cash on hand	82 81
Net Deficit	$148 00

Auditors: L. Caesar.
J. E. Howitt.

Entomological Society of Ontario

ANNUAL MEETING.

The Fifty-sixth Annual Meeting of the Entomological Society of Ontario was held at Ottawa on Thursday and Friday, November 6th and 7th, 1919. The chair was occupied by the President, Prof. L. Caesar.

The following members were present: Prof. W. H. Brittain, Truro, N.S.: Mr. George Sanders, Annapolis Royal, N.S.; Mr. J. D. Tothill, Fredericton, N.B.: Prof. W. Lochhead, Macdonald College, Que.; Mr. A. F. Winn, Westmount, Que.: Dr. J. A. Corcoran and Mr. G. C. Moore, Montreal, Que.; Rev. Father Leopold and Mr. F. Letourneaux, Oka, Que.: Mr. C. E. Petch, Covey Hill, Que.: Dr. C. G. Hewitt and J. McDunn: Messrs. A Gibson, J. M. Swaine, C. B. Hutchings, E. F. Strickland, F. W. L. Sladen, C. B. Gooderham, J. I. Beaulne, L. S. McLaine, V. Kitto and Drs. J. McDunnough and S. Hadwen, Ottawa, Ont.: Mr. F. J. A. Morris, Peterborough, Ont.; Mr. H. F. Hudson, Strathroy, Ont.; Mr. W. A. Ross, Vineland, Ont.; Mr. N. Criddle, Treesbank, Man., and Mr. R. C. Treherne, Vancouver, B.C.

Among the visitors were Mr. C. L. Marlatt, Washington, D.C.; Prof. Cummings, Mass.; Prof. W. A. Macoun and Mr. E. S. Archibald, Ottawa.

Letters of regret at their inability to attend the meeting were received from the following: Dr. W. E. Britton, New Haven, Conn.: Prof. G. C. Crampton, Amherst, Mass.; Dr. E. P. Felt, Albany, N.Y.: Dr. H. T. Fernald, Amherst, Mass.: Dr. T. J. Headlee, New Brunswick, N.J., and Mr. J. J. Davis, Riverton, N.J.

On Thursday morning a meeting of the Council was held at which several matters of importance to the Society were brought up and discussed. In view of the increasing deficit shown by the Treasurer's Report it was decided that the fee to Canadian members of the Society, including members of Branches, be increased to $2.00, and that in lieu of all expenses only the railway fares of the Directors and Officers of the Society be paid.

In the afternoon the general meeting was called to order by the President and the proceedings commenced with the reading of the Report of the Council, followed by those of the Treasurer, Librarian, Curator and of the various Branches of the Society.

REPORT OF THE COUNCIL.

The Council of the Entomological Society of Ontario begs to present its report for the year 1918-1919.

The Fifty-fifth Annual Meeting of the Society was held at the Ontario Agricultural College, Guelph, on Wednesday and Thursday, December 4th and 5th, 1918. Owing to the prevalence of influenza, the meeting was held at a much later date than usual. The chair was occupied by the President, Professor Lawson Caesar, O. A. College. The attendance was very good, including members of the Society from Nova Scotia, New Brunswick, Quebec, Ontario and Manitoba. Mr. J. J. Davis, West Lafayette, Ind., Prof. J. P. Parrott, Geneva, N.Y. and Prof R. Matheson, Ithaca, N.Y., were welcome visitors.

By the kindness of Dr. Creelman, all those in attendance who came from a distance, were entertained in the College Residence during their stay in Guelph. This arrangement added much to their pleasure and comfort by affording many opportunities for social converse and by saving the time usually spent in travelling to and from the town. This hospitality was greatly appreciated by all present, and a hearty vote of thanks was accorded at the close of the meeting to President Creelman and to the Matron and the Superintendent of the Dining Hall.

At a meeting of the Council, held on Wednesday morning, it was decided to enlarge the pages of *The Canadian Entomologist* in order to be uniform with the standard size of bulletins, and also to issue ten instead of twelve numbers per annum, but at the same time to make no reduction in the amount of reading matter.

During the afternoon of Wednesday and on Thursday, a number of interesting and valuable papers were read and discussed, of which the following is a list:— Reports on insects of the year in their respective districts by Directors, Dr. A. Cosens, Toronto, Mr. F. J. A. Morris, Peterborough and Mr. J. W. Noble, Essex. Insects of the season in Ontario, by Mr. W. A. Ross, Vineland, and of Quebec by Mr. G. Maheux, Quebec; "Aphids; their human interest," by Dr. A. C. Baker, Washington, D.C.; "Insect problems in the Prairie Provinces," by Mr. Norman Criddle, Treesbank, Man.; "The recovery in Canada of the Brown-tail Moth Parasite, Compsilura concinnata," by Messrs. J. D. Tothill and L. S. McLaine; "The Life-history of a Hobby Horse" by Mr. F. J. A. Morris; "Present day problems in Entomology," by Mr. J. J. Davis; "Insects as agents in the dissemination of Plant Diseases," by Prof. Caesar; "The Cabbage-root Maggot," by H. C. Huckett; "Some chapters of the early history of Entomology," by Prof. Lochhead; "The Pear Psylla in Ontario," by Mr. W. A. Ross; "Our Garden Slugs," by Mr. G. Maheux; and "The Entomological Record for 1918," by Mr. Arthur Gibson. The reports of the Montreal, Toronto, Nova Scotia, and British Columbia Branches and of the Librarian and Curator were also presented and read.

The Canadian Entomologist, the official organ of the Society, completed its fiftieth volume in December last; the event was commemorated by a poem from the pen of Mr. F. J. A. Morris, which opened the fifty-first volume. This volume will be completed by the issue of the forthcoming November and December numbers. The semi-centennial volume contained 433 pages, illustrated by 12 full page plates and 21 figures in the text. The contributors to its pages numbered 57 and included writers in Ontario, Quebec, Nova Scotia, Manitoba, Alberta and British Columbia, and also in twelve of the United States. In the systematic articles there were described five new genera, 103 new species and four new varieties of insects. The series of papers published each month on "Popular and Practical Entomology" has continued to form an attractive as well as an instructive feature for the benefit of the general reader.

The number of members of the Society continues to be much the same from year to year. At the end of 1918 there were 179 on the list, including those on military service overseas. During the current year 26 have left us owing to deaths and withdrawals, while the same number of new members has been added to the roll.

It is again the sad duty of the Council to record the loss of one of our ablest and most active Entomologists, Mr. Frederic Hova Wolley Dod, of Midnapore, Alberta, who died of Enteric Fever on the 24th of July, at 49 Hospital, Chanak. His rank was Second Lieutenant in the Yorkshire Light Infantry attached to the

Macedonian Labour Corps. Though beyond the age prescribed for military service, his patriotic spirit compelled him to do what lay in his power for the welfare of the Empire. He accordingly went to England and succeeded in obtaining a commission and being sent out with a Labour Corps to Macedonia. Mr. Wolley Dod devoted himself to the Lepidoptera and became the highest authority in North America on the Noctuid Moths. He published in the *Canadian Entomologist* a long series of papers, extending over many years, on the synonymy and classification of this difficult family.

REPORT OF THE LIBRARIAN.

Owing to the lack of funds available for the purpose, only one book has been bought for the Library during the year now drawn to a close, namely, "Illustrations of the North American species of the genus Catocala" by Drs. Barnes and McDunnough, published by the American Museum of Natural History, New York. Seven bound volumes have been received, making the total number 2,292. A notable gift to the Library has been made by the Rev. Dr. Fyles, a Life-member and Ex-President of the Society. It is a large folio volume, handsomely bound in red leather and entitled "Illustrations in Natural History." It contains 107 water-colour drawings, chiefly of insects, but including a few depicting flowers, birds, reptiles and other creatures. It was presented by the author "as a token of his appreciation of the great pleasure and profit his connection with the Society has afforded him."

The Library continues to receive a large number of periodicals in exchange for *The Canadian Entomologist* and a great variety of bulletins, reports and pamphlets, many of which should be collected into volumes and bound for convenient reference.

CHARLES J. S. BETHUNE, *Librarian.*

REPORT OF THE CURATOR.

Mr. Eric Hearle resigned the position of curator last spring on account of his departure for British Columbia where he has been studying mosquitoes during the summer. In the meantime I have myself, assisted at first by Mr. H. G. Crawford and later by Mr. G. J. Spencer, looked after the collection. They are all in good condition and have been so throughout the year. Very few new insects have been added.

L. CAESAR, *President.*

REPORT OF THE TORONTO BRANCH.

October 9th, 1919.—The 23rd Annual Meeting of the Toronto Branch was held in the Biological Building of the University of Toronto.

The report of the Council showed that seven regular meetings and one annual meeting were held during the year, and that the average attendance was fifteen persons.

The annual meeting held on November 21st, 1918 was an open meeting for general discussion of entomological topics. But at the regular meetings a variety of papers were read, these were as follows:—

Dec. 6th,1918—"The Natural Control of Insects." By Mr. John D. Tothill, of Fredericton, N.B.
Jan. 9th, 1919—"Insects as Food of Trout." By Dr. W. A. Clemens.
Feb. 6th, 1919—"A Month on the Lower St. Lawrence." By Dr. E. M. Walker.
Feb. 27th, 1919—"Notes on the Biology of Stoneflies." By Mrs. W. A. Clemens.
Mar. 21st, 1919—"Insect Life in British Honduras." By N. K. Bigelow.
April 24th, 1919—"Investigations into the Habits of the Nymphs of the Mayflies of Genus Chirotonetes." By Dr. W. A. Clemens.
Also "Insectivorous Birds in Ontario." By Dr. E. M. Walker.
May 29th, 1919—"The Food and Feeding Habits of some Larval Hymenoptera." By Dr. A Cosens.

The report of the Librarian showed that many publications had been received during the year, and that these had been catalogued and filed.

The financial statement showed a balance on hand of $22.47.

It was owing to the epidemic of influenza in the autumn of 1918 that the annual meeting was not held until November.

Three new members: Mrs. W. A. Clemens, Mr. N. K. Bigelow, and Mr. H. Hesket were elected during the year.

After the reading of the annual report, one new member, Mr. R. W. Hall, was nominated and elected a member of the Toronto Branch.

The election of officers was then proceeded with, the results were as follows:

President, Mr. H. V. Andrews; Vice-President, Mr. S. Logier; Secretary-Treasurer, Miss Norma Ford; Librarian, Mr. N. K. Bigelow; Council, Dr. E. M. Walker, Dr. W. A. Clemens, Dr. A. Cosens, Mr. T. B. Kurata, Mr. J. Hannibal, Mr. C. K. Brobst.

When the annual business was finished the meeting was left open for general discussions in entomology and for notes and observations of the season. Those present at the meeting were: Dr. Clemens, Dr. Walker, Miss Ford, Mr. A. W. Baker of the Parent Society, Messrs. Andrews, Hannibal, Wright, Bigelow, Hall, Logier, and two visitors.

It is with sincere regret that the Toronto Branch record the death of Mr. Chas. M. Snazelle, who had been a member since 1912. During the last two years he had been unable to attend the meetings owing to business obligations in connection with war work. Mr. Snazelle was an enthusiastic student of nature both in entomology and in other branches, and his presence at our meetings will be greatly missed through the coming days.

Shelley Logier, *Sec.-Treasurer.*

REPORT OF THE MONTREAL BRANCH.

The 46th Annual Meeting of the Montreal Branch of the Entomological Society of Ontario was held in the Lyman Entomological Room, Redpath Museum, McGill University, on May 17th, 1919.

During the season 1918-1919 we held eight meetings with a total attendance of seventy or an average of nine per meeting. This was smaller than that of the

previous season, which however was the largest on record because of a large public meeting held in 1918. We did not hold such a meeting during the past season, but nevertheless we had successful meetings and the interest was keen.

We have added several recruits to our ranks and hope they will all become ardent entomologists.

We held our regular Victoria Day outing to St. Hilaire and those who were able to go were rewarded as usual from this good collecting ground.

Our Society provided the programme at the Natural History Society's meeting in March.

The Treasurer's Report showed a balance of $158.61 on hand.

The following papers and talks were given during the year:—

1. Annual Address, Subject "Tables" ..... A. F. Winn.
2. Collecting in California ..... H. F. Simms.
3. Preparation of Hemiptera lists ..... Geo. A. Moore.
4. Hemiptera taken at St. Hilaire, May 24th, 1918 ..... Geo. A. Moore.
5. Larvæ of Parnidae ..... Dr. F. S. Jackson.
6. Notes on the Season 1918—"Hemiptera" ..... Geo. A. Moore.
7. Argynus apachana St. and Edwards' Plates of A. nokomis .... A. F. Winn.
8. Economic importance of Samia Cecropia ..... Dr. Corcoran.
9. Enodia portlandia Fab. at Oka ..... G. Chagnon.
10. Zerene cæsonia Stal. the Dog's Head Butterfly ..... A. F. Winn.
11. On which plant to collect Chalæpus nervosa Say ..... Brother Ouellet.
12. The Milkweed Bug. Lygæus Kalmii Stal. ..... Geo. A. Moore.
13. British Burnets ..... Lachlan Gibb.
14. Muscoid larvae found in a human patient ..... Dr. F. S. Jackson.
15. The Raspberry Root Borer or Clear Wing Borer, Bembecia marginata Han. ..... A. F. Winn.
16. Notes on some localities outside Montreal Island ..... Brother Ouellet.
17. The Periodical Cicada ..... Geo. A. Moore.
18. Lantern Lecture, Nature Photography ..... G. H. Hall.
19. Cercopidæ, Spittle Insects ..... Geo. A. Moore.

Geo. A. Moore, *Secretary.*

REPORT OF THE BRITISH COLUMBIA BRANCH.

The 18th Annual Meeting of the British Columbia Branch was held in the biology lecture room at the University of British Columbia, Vancouver, on Saturday, March 15th, 1919. In the absence of the President, Mr. R. S. Sherman, owing to sickness, the chair was taken by the Vice-President for the Coast, Mr. W. Downes.

The Secretary-Treasurer, Mr. Williams Hugh, presented his financial statement and report as librarian. The morning session included the following programme:—

Discussion on Aims and Objects of the Society.
Resolutions.
Notes on Tubuliferous Thysanoptera ..... R. C. Treherne.
Stray Notes on B. C. Lepidoptera ..... E. H. Blackmore.
Common Tree-hoppers of B. C. ..... W. Downes.
Some descriptions of New Species of Mycetophilidae ..... R. S. Sherman.

Afternoon Session.

A Swarm of Vanessa californica ..... J. W. Cockle.
The Lycaenidae of B. C. ..... E. H. Blackmore.
(Illustrated with Specimens)
The Locusts of B. C. ..... E. R. Buckell.
Discussion by Thos. MacKenzie, B. C. Commissioner of grazing.
Notes on European Foul Brood in B. C. ..... Williams Hugh.
Cutworm Control ..... Mr. H. Ruhman.
Life Histories and Control of Our Strawberry Insects ..... W. Downes.

Evening Session.

The Onion Maggot ..... Mr. H. Ruhman.
Tent Caterpillars, their life-history and control ..... A. B. Baird.
The Alfalfa Seed Chalcid ..... E. R. Buckell.
Insect notes of the year, leading a discussion on control of injurious insects affecting Agriculture ..... R. C. Treherne.

The officers elected for the year 1919 were as follows:—

Hon. President ..... F. Kermode, Victoria
President ..... E. H. Blackmore, Victoria.
Vice-President (Coast) ..... R. S. Sherman, Vancouver.
Vice-President. (Interior) ..... J. W. Cockle, Kaslo.
Hon. Secretary-Treasurer ..... W. Downes, Victoria.
Advisory Board ..... Messrs. Lyne, R. C. Treherne, G. O. Day, John Davidson, L. A. Breun.

Among the resolutions passed was one providing for prizes at the principal fall fairs for the best exhibits of insects collected by students attending the public schools, $100.00 being voted for this purpose from the Society's funds.

The Society at the present time is in a flourishing condition and although interest in the Society's work diminished during the war, in which two valued members lost their lives, we have since been strengthened by the addition of several new members and signs are not wanting that interest in the work of the Society will continue to increase.

W. Downes, *Hon. Secretary-Treasurer.*

REPORT OF THE NOVA SCOTIA BRANCH.

The Fifth Annual Meeting of the Entomological Society of Nova Scotia was held at the College of Agriculture, Truro, on July 31st. The morning session was devoted to a report of the Society's work, financial statement, and the general business of the Society. During the afternoon and evening a number of papers were read by various members.

The following officers for the year were elected:—

Honorary President ..... Dr. A. H. McKay, Halifax.
President ..... W. H. Brittain, Truro.
Vice-President ..... J. D. Tothill, Fredericton.
Secretary-Treasurer ..... A. Kelsall, Annapolis Royal.
Asst. Secretary-Treasurer ..... E. A. McMahon.
Committee ..... W. N. Keenan, G. E. Sanders. Miss Dora Baker.

During the year, No. 4 of the Proceedings of the Entomological Society of Nova Scotia was issued, a publication comprising about a hundred pages. Besides including a great deal of new data on the insects of the Maritime Provinces, it contains several articles on comparatively new, or modified, insecticide-fungicide combinations, which are proving to be of considerable economic value.

A. KELSALL, *Secretary.*

REPORTS ON INSECTS FOR THE YEAR.*

DIVISION NO. 3, TORONTO DISTRICT—A. COSENS.

The frail structure of many insects adapts them only to the warmth and soft breezes of summer, not to the cold and bitter gales of winter. In bridging the period of low temperature the casualties must be heavy among these fairy-like creatures of sunny, dreamy days. Last winter was so uniformly and extremely mild that the hibernating conditions of many groups of insects were no doubt ameliorated, and, as a result, an unusually large number of survivors awakened into activity at the beginning of the season.

This may explain in part the abundance of several species of butterflies. On May 7th, which was a very warm spring day, many specimens of the Red Admiral, *Vanessa atalanta,* emerged from their winter hiding-places. Dozens of them were skimming lazily over the lawns or flitting about among the blossoms of the Norway maples. From that date throughout the whole summer these butterflies were exceedingly numerous, more so than for many years. Later in the season, the Painted Lady, *Vanessa cardui,* also became very plentiful and continued so until nearly the end of August. The Banded Purple, *Basilarchia arthemis* usually a rather scarce butterfly in this locality, was quite frequent along the paths in the parks. Its relative, the Viceroy, *Basilarchia disippus,* never a rare insect here, was this summer, however, uncommonly abundant.

The hibernating habits of these last two species are such as to point to the possibility of a close relation between their unusually large numbers and the mildness of the winter. As soon as the nights begin to become cool, the caterpillars of the butterflies commence the preparation of their winter quarters. The larva selects a suitable leaf on its food plant, and bites off the blade on each side of the midrib, leaving only two flaps at the base. The whole of the leaf remaining is then covered with silk, and the flaps are drawn together so as to form a cosy silk-lined nest. To prevent the leaf from falling some of the threads of silk, that covered its stalk, were passed around a branch of the plant. Into this Esquimaux-like sleeping-bag the caterpillar then crawls, and remains in its snug retreat until the spring sun has burst the buds on its food plants.

Gardeners state that the Cabbage Butterfly, *Pieris rapae,* has been very trouble some this season. It is only seldom that the southern relative of this form comes so far north, but on August 1st, I captured a much-worn female specimen of *Pieris protodice.* The latter species has never proven injurious in Ontario, but is occasionally numerous enough to become destructive in some of the states to the south of us. Throughout the whole of its range, however, this native American butterfly is being gradually driven out by the alien from Europe. The latter, by ovipositing earlier and raising more broods a year, has been able to gain possession of almost all the available, cultivated Cruciferous plants, limiting the former to the wild species only.

*For Report of Division No. 6, see p. 83.

August 1st must have been a red-letter day in the entomological calendar as I find in my notes that on that date I captured also the Zebra or Papaw Butterfly, *Iphiclides ajax* var. *ajax*. A strong southern wind that had been blowing for a couple of days may account for these rare stragglers from the south. Speaking of Papilios, it is interesting to note that the Pipe-vine Swallow-tail, *Papilio philenor*, is becoming less rare in this district. This is probably due to the increasing popularity of its favourite food-plant, the Dutchman's Pipe, *Aristolochia macrophylla*, for ornamental purposes.

Although many species of butterflies were exceedingly common this season the Monarch, *Anosia plexippus*, was much less plentiful than usual. I saw only four specimens, and these late in the year—September 7th, 9th and 14th. In a note just received from Mr. C. W. Nash he states that he saw a specimen on each of the dates, September 26th, October 4th and 5th. These butterflies, that have visited us so late are probably members of the rear guard of the migrating columns on their treck to the south from a more northerly summer home.

The Entomological season was opened on April 5th this year by the finding of four specimens of the Ground Beetle, *Calosoma calidum*. In spite of the early date, a pair of these insects were already mated. On two occasions this summer I have seen the larvæ of Ground Beetles attacking earthworms. The beetles were finding their prey rather large, and one at least of the worms escaped.

Some variation in the conditions has proven favourable to the production, this season, of the gall *Andricus operatola* Bassett. On the ground, under several oak trees, infested acorns were plentiful. In previous years it has been rarely that I have found the gall, and never before attached to the acorns. The specimens obtained had dropped from the acorns which had remained on the trees.

This pointed, tooth-shaped gall is enclosed between the cup and the acorn, but originates from the latter. In general the gall projects only slightly above the edge of the cup. Often four or five galls are found irregularly spaced around the base of an acorn. In this locality both red and black oaks act as hosts.

From the galls, that have remained on the ground over winter, producers emerge early the next spring.

Division No. 4, Peterborough District—F. Morris, Peterborough.

One or two items only seem worthy to be reported in this season's collecting. The interruption of school work owing to influenza, in October and November, necessitated the extension of the summer term till the end of June; almost immediately after, your director passed to examination work till late in July. Field observations were very few and not of much value.

Among the collections handed in by pupils at the Peterborough Collegiate was noticed a very rare borer in alder, *Saperda obliqua*, and a member of the staff captured three or four specimens of *Phymatodes dimidiatus* in the latter part of May, the captures being made in his woodshed. A few days after a pupil brought in a specimen of *Saperda puncticollis* just captured on Virginia Creeper. This insect had been taken two or three times by pupils and I was very anxious to make observations. Enquiries had always pointed to Virginia Creeper rather than Poison Ivy as the food plant. The Science teacher accordingly hurried over to examine the vine and captured four or five more specimens, as well as specimens of *Psenocerus supernotatus* emerging from dead stems of the same plant. On learning of the discovery I hurried over to our opposite neighbor's where the low wall is overgrown with the plant in question. I captured over a score of the first insect and three or four of the second. Casual search on four or five other vines

of Virginia Creeper at different parts of the city secured further specimens of both insects. The beetle is quite the prettiest of the Saperdas, but small, shy, and easily overlooked. In the hot sun it often climbs out to the surface of the upper leaves, but takes to wing very readily and drops as readily into the heart of its shrubbery. The period of emergence and activity lasts about a fortnight; from May 27th to June 10th. Large numbers of a clearwing moth were observed frequenting blossoms along the edge of a corduroy road through the heart of a tamarac swamp, but so far the insect has not been determined. No other insects of interest have been noted by your observer this season.

Division No. 5, Essex District—J. W. Noble, Department of Agriculture, Essex.

Attacking Field Crops. Hessian Fly has been very conspicuous in its work this year, large acreages of wheat have been cut down in yield 50 per cent. and even some of the later sown wheat planted in the fall of 1918 have been badly attacked. A great deal of injury has already been noticed this fall. It is altogether likely to be as bad in 1920 as this year. Grasshoppers and crickets were quite bad in June owing to extremely dry weather prevailing at that time. Considerable damage was done to cereal grains and some other crops by these insects. Wire-worms and cutworms did a great deal of damage in the spring of 1919. Cut-worms have been quite successfully controlled by the poison bran mixture.

Attacking Fruit Trees. The Codling Moth has possibly never been worse in this county owing to the exceptionally favourable season for its development. Even well-cared-for orchards are heavily infested with this insect. Where the spraying was omitted in the season of the year three weeks after the blossoms have fallen the sideworm injury is especially conspicuous, but in well-cared-for orchards that received the calyx cup spray very little injury has been noticed from the blossom end. A considerable number of specimens at work of Plum Curculio have been submitted for identification, but commercially speaking, the Codling Moth has been much the worst insect on fruit trees.

Fruits and Vegetables. The Onion Marsh at Leamington where about 500 acres were grown this year had considerable trouble from both root maggot and onion thrips. Very little success has been obtained from trying to combat either of these pests.

Aphids were very bad this season on cucumbers but did not seem to do much damage to melons. The general use of Black Leaf 40 and tobacco decoction have been very successful in combating these insects. Tomatoes have been greatly infested this year with Tomato Sphinx, crickets and grasshoppers. Cauliflower plants have suffered considerably from crickets gnawing the stems above the roots. Considerable dame was done, but wet weather checked their depredations before poison solution could be tried.

Tobacco was attacked by the usual pests, the tobacco sphinx being very plentiful this year. Dusting the small plants with arsenate of lead, spraying the partly grown plants with solution and spraying the larger plants with the dust gun when they were too large to allow the spray machine to be used successfully, controls these worms. Wire-worms did an exceptional amount of damage to tobacco plants this year and made the stand very uneven in many cases.

Greenhouse Insects. The usual greenhouse insects have been reported, but where proper methods have been used very little trouble has been reported. Green-house white fly, greenhouse aphids and nematodes are among the greenhouse man's worst enemies.

ENTOMOLOGICAL PROGRESS IN BRITISH COLUMBIA.

R. C. Treherne, Entomologist in Charge for British Columbia, Dominion Department of Agriculture.

The products of entomological labors during the past year in British Columbia have been many and varied. In addition to my work as a Federal Officer under the Dominion Entomological Branch, I have undertaken the general direction of the Provincial Entomological work, pending the appointment of a Provincial officer. Under the Dominion Entomological Branch, Messrs. W. Downes and E. P. Venables are engaged, the former on a study of small fruit insects in the Coast sections and the latter on a study of tree fruit insects in the interior of the province. Mr. A. B. Baird is stationed at Agassiz, B.C., working under the general direction of Mr. J. D. Tothill, who has charge of the Federal Natural Control Investigations. His work has been mainly a study of the natural control agencies of the Tent Caterpillar, the Fall Webworm and the Spruce Bud-worm, and these studies begun by Mr. Tothill in 1917 have been continued by Mr. Baird in 1918 and 1919, at Victoria, Vancouver, Agassiz and Lillooet. Mr. Eric Hearle commenced a study of the mosquitoes in the Lower Fraser Valley of British Columbia in March 1919, acting conjointly under the authority of the Dominion Entomologist and under a studentship granted by the Honorary Advisory Council for Scientific and Industrial Research, and he will doubtless not only continue this work in the Lower Fraser Valley but extend it over the province at other important centres. Mr. Ralph Hopping was appointed under Dr. J. M. Swaine, Chief, Dominion Division of Forest Insects, in December, 1919, and he is stationed at Vernon, B.C., engaged on the studies relating to certain forest infesting insects, particularly some *Dendroctonus* beetles affecting commercial pine.

Under the Provincial Entomological Branch, I am fortunate in being associated with Messrs. M. H. Ruhman and E. R. Buckell. The former is engaged in a study of vegetable insects and has made the study of the Root Maggots of the onion and the cabbage his special work during the past two years. Mr. Buckell has taken in hand studies relating to cereal and range insects, the most pressing problem, at the present time, being the control and investigation of locusts on the range.

Vernon, at the north end of Okanagan Lake, has been selected as the headquarters for entomological work in the Province at the present time. Here the central office is located with a reference library and collection of insects for study available to members of the staff, and Riker Mounts and photographic displays of insect pests, in appropriate arrangements, of interest to farmers. Branch laboratories have been established at Victoria, Agassiz and Mission. Another movable laboratory was stationed at Penticton in 1919 but doubtless will be located in the Chilcotins in 1920.

During the past year, 1919, the following investigations have been conducted, excluding the reports of Messrs. Hearle and Baird, who will issue the results of their work independently.

The Peach Twig Borer, *Anarsia lineatella,* was studied at Penticton, making the second consecutive year in which this insect has received attention. We are satisfied that the early application of lime-sulphur, 1-9, as close to, but previous to, the blossoming period as possible, will achieve good commercial results. Applications of arsenate of lead may be made immediately after blossoming with

equally good results. The two applications of spray may be made in cases of severe infestation. This insect is known to attack prunes, plums, peaches, apricots, and cherries, and where these fruits are seriously attacked the same procedure for control, as outlined above, may be followed.

Certain studies were undertaken at Vernon this year to breed to maturity the various "worms" affecting fruit. This work was carried out to determine with accuracy the species present in the fruit orchards and to differentiate between the larvæ of the various species for the purpose of assisting in diagnosing outbreaks of Codling Moth. The following species occur: *Tmetocera ocellana, Argyroploce consanguiniana, Cacoecia rosaceana, Mineola tricolorella,* and *Laspeyresia prunivora.*

Insect distributors of fire blight were also the subject of study. Many insects received attention in this connection and while some were incriminated as carriers of both summer and winter blight, it is not believed that their control will either eliminate the disease or control it to the extent expected by many growers.

The Strawberry Root Weevil, *Otiorhynchus ovatus,* is still being subjected to investigation, the main line of work being a demonstration in the principles of crop of rotation. A section of land has been engaged for a period of six years to put into practice the remedies for this weevil which we believe may be successfully held in control by cultural methods. Mr. W. Downes, assistant in charge of this work, has recently shown that the weevils are parthenogenetic and that certain overwintering females may oviposit in the early spring months.

The chief small-fruit insects, with the exception of the Strawberry Root Weevil, which is the most serious, are the following: *Bembecia marginata, Phorbia rubivora, Aristotelia fragariae, Synanthedon rutilans, Epochra canadensis,* and an *Empoasca* of the Loganberry. It is hoped that all these insects will be studied closely during the next few years. With *Epochra canadensis* we have been unable, thus far, to prove any value from the poisoned bait spray and are still recommending growers to rely on cultivation and the use of chickens to rid themselves of this pest.

Among the vegetable insects the Cabbage Root Maggot and the Onion Maggot were each the subject of considerable study. The bulk of the work against the Cabbage Root Maggot is recounted on another page of these proceedings. The work against the Onion Maggot has not resulted, as yet, in our being able to offer definite recommendations for control under field conditions as they pertain to the Okanagan Valley. Our efforts to test the value of the poisoned bait spray have not apparently been rewarded with success. Our inclinations lead us to believe that late thinning and the use of a spring trap crop have considerable value, and in this belief our growers are recommended, at present, to plant a few rows of cull onions, 3-4 inches deep in the soil, in the early spring months, allowing the onions to sprout and thus act as a trap crop for the first generation of the fly. The work with the poisoned bait spray, which is, according to report, giving very good results in Eastern Canada and in the Eastern United States, is being continued. Consequently it is hoped that our recommendations will assume a more definite state in a few years' time.

Among the insects affecting grain and range crops, the locusts situation received considerable attention during the past year. The main species involved were *Camnula pellucida, Melanoplus atlanis* and *M. femur-rubrum.* The paper in this number of the Proceedings by Mr. E. R. Buckell, on some ecological and life history notes of locusts, covers in part, the work accomplished.

Spraying investigations that are being carried on, at present, in the Province, are being maintained by the Provincial Horticultural Division. Their main in-

vestigations have been conducted against the Green Apple Aphis, in order to determine the cheapest spray to apply; and against Apple Scab where different mixtures, strengths, and formulae have been used in test against each other. The Codling Moth field work has also been in the hands of the Provincial Horticultural authorities, working in association with the officers of the Entomological Branch. Approximately 223 acres of apple orchards were handled under quarantine in the neighbourhood of Vernon during the past year. 107 acres of this 223 were infested with Codling Moth in the year previous, 116 acres were contiguous to the infested area and were treated as though infested. 11,422 apple trees in this acreage were banded and were sprayed three times, and at the end of the season 19,401 boxes of apples were individually examined for larvæ. Altogether 373 larvæ and pupae of the Codling Moth were taken at Vernon, and as Vernon, during 1919, was the only point in the Okanagan Valley where examples of this moth were taken, the control operations have succeeded to a very creditable degree. A few years ago three distinct and separate outbreaks of the moth occurred in the Okanagan Valley, with as many as 10,000 larvæ being taken in a single year. The record as it stands, therefore, is not only very encouraging but is an indication that incipient outbreaks, in small areas, with proper support by the growers, can be not only reduced but also eradicated. A small new outbreak of this pernicious pest occurred at North Bend this year, which will necessitate action this coming year.

The Tent Caterpillars, *Malacosoma pluvialis* and *M. erosa* were exceedingly common at Vancouver and Victoria in 1919. The outbreak at certain points being exceptionally severe. A memorandum outlining the method for control was submitted to the City Councils of the Cities of Vancouver and Victoria, but with this exception, these insects were studied exclusively by Mr. Baird.

Many sundry insect notes were collected during the course of the year and the more important minor records have been incorporated in a report to the Department of Agriculture, Victoria, B.C. A similar report for the year 1918 was submitted in the same way to the Provincial Department of Agriculture and was published in two sections in the official organ of the Department, the *Agricultural Journal*.

RESULTS OF SOME PRELIMINARY EXPERIMENTS WITH CHLOROPICRIN.

G. J. Spencer, O. A. College, Guelph.

In 1917, when meditating upon the effects of enemy gas that I had received at Passchendaele it occurred to me that British gas might be turned upon enemies other than Germans.

The opportunity to try this out came in the spring of 1919 when the Khaki University of Canada obtained permission for men of the Canadian forces to study at British Universities. I went to Victoria University, Manchester, where through the courtesy of Prof. S. J. Hickson, I was given the run of the research laboratory and the insectaries at Fallowfield. From the explosives department of the Ministry of Munitions I obtained samples of three of our common battle gases, one of them being chloropicrin, formula tri-chlor-nitrite.

It was decided to try the effects of these gases with a view to greenhouse, flour-mill and domestic fumigation. There was time to carry out only one experiment in Manchester before I was recalled to camp.

Experiment of Chloropicrin on Plants in a Greenhouse..

Capacity of greenhouse, 675 cubic feet approximately. Temperature in the house (June) 90° F. Ten cubic centimetres of gas were used in each of three petri dishes, two in opposite corners of the room on a table, and one on the floor. The nearest dish was right amongst the plants, which were: Recently potted dandelion in flower, Michaelmas daisy, wild vetch and curled dock, a geranium in a pot and cut boughs of willow. Insects present: Thrips, geometrid larvæ, leaf-rollers, Cercopidae, immature Jassidae and some Muscidae flying around the room.

A gas mask was used throughout the experiment in order to observe the action of the gas on the insects.

The leaf-hoppers were the first to show signs of distress by falling off the willow boughs six minutes after the gas was introduced. At the end of 10 minutes and 20 minutes respectively 10 cubic centimetres more of gas were poured out, this time on the floor making a total concentration of 50 c.c. After an exposure of 23 minutes the thrips were apparently all dead, although they had fallen out of the flowers after 11 minutes. At this time the Jassids and the immature Cercopids whose spittle masses had not been disturbed at all were also on the table moving feebly.

The experiment terminated in 38 minutes with the thrips, Jassids and Muscids all dead and the cercopids, the geometrid and leaf rollers very feebly moving. The doors and windows were opened and kept open until the house could be freely entered without discomfort, the gas being dispelled in 5 minutes. Next morning, i.e. after 17 hours those insects which had been feebly moving the day before were all dead. The cercopids alone, in untouched masses of spittle, were apparently unharmed. But all the plants were drooping badly, especially the vetch and michaelmas daisy, and at the same hour the second day, all the plants were dead.

In this experiment the temperature was very high and the relative humidity must have been high also as the floor of the house had been recently watered. But the volume of gas was very low, being for half the experiment only 30 c.c. and at the end of the experiment only 50 c.c. per 675 cubic feet, which amounts to only 3.7 oz. per 1,000 cubic feet.

With these results in mind, the following experiments were carried out at Guelph, the relative humidity being determined in each case:

1. Varying strengths of gas—other factors being equal.
2. Shorter or longer period of exposure.
3. Exposure by night and by day.
4. The killing power of the gas on various insects.

A good supply of Red Spider on salvia and of mealy bugs on coleus was available in the greenhouses of the College and as both these host plants show great susceptibility to killing by hydrocyanic gas, it was considered advisable to try the comparative value of chloropicrin on them.

Experiments were conducted at first in daylight, and proved that exposure to an atmosphere at the rate of 3 pounds of gas per 1,000 cubic feet, relative humidity 87, temperature 55.8° F. kill red spider effectively in 8 minutes—but kill salvia host plants in 5 minutes. And while 40 minutes exposure kills coleus and begonia, it does not kill all the mealy bug; those with their mouth-parts inserted in the stem of the plant seeming to survive those that were moving about. By next day young were issuing freely from the egg masses.

Effect of Gas on Various Insects.

The effect of the gas was tried also on leaf-hoppers and aphis on rose, red spider on salvia, tarnished plant bug and mites on aster and on cutworms. Temperature 66.2° F. Relative humidity 89. Concentration 3 lbs. per 1,000 cubic feet.

Result. Some leaf-hoppers died in 4 minutes, others in 14 minutes; red spiders and aphis seemed to be killed in 8 minutes. The aphis do not remove their beaks from the plant. On the insects being removed from the chamber at the end of 30 minutes, the capsids, cutworms and a few aphis that had been covered under a mass of leaves were still kicking feebly. After being exposed to the air for one hour everything was seen to be dead.

The action of choloropicrin on man is cumulative, and this would seem to be the case with insects also. In most instances, insects that may be kicking feebly when removed from the gas die after a while, even if placed in a current of fresh air.

Effect of rapid concentration. To determine if a sudden rush of gas would prove more effective even in reduced quantity, choloropicrin at the rate of 1½ pounds per 1,000 cubic feet was heated in a retort over a spirit lamp and the gas introduced into the chamber through rubber tubing. Mealy bug on begonia were the insects and plants used. Temperature 68° F. Relative humidity 82. The gas was practically volatilised in 14 minutes. When heating ceased and the plant was left in the chamber for two hours and then removed, on removal a few bugs showed signs of life but these died in three or four hours. Unfortunately the plant was withering at the time of removal.

Experiments at night. Finally, gas was used on red spider and mealy bug at night at a strength of 8.7 oz. per 1,000 cubic feet, temperature 59.0° F., relative humidity 99. Plants used salvia and coleus. Exposure lasted 90 minutes and by this time all red spider and mealy bug were dead; plants apparently normal. Next morning both species of plants were withering.

Inferences from foregoing experiments. It would seem that chloropicrin cannot be used for greenhouse fumigation as it has deadly effects on plants.

Penetration in earth. To test the penetration of the gas in earth, a flower pot about 7 inches deep, of ordinary greenhouse potting soil was used. Earth worms and millipedes were placed at different depths. (1) On the surface, (2) 1½ inches down, (3) 5 inches down. Experiments done at night, concentration at the rate of 8.7 oz. per 1,000 cubic feet. Time of exposure to gas 11 hours and 30 minutes. Temperature 55.4° F., relative humidity 88.

Result. Of those millipedes on the surface, some had crawled off the soil and some into it. Those at 1½ inches depth had gone deeper. At the end of the experiment all the millipedes and worms appeared dead, and while after 51½ hours the largest millipedes showed slight movement, the worms were all dried up. Eight hours afterwards another large millipede was bending slightly, but 12 hours after, all were dead without having moved from their original positions.

Effect of Chloropicrin on House Furnishings.

With a view to finding out if choloropicrin would have any effect on furnishings in houses, the following articles were exposed to its vapors for 12 hours: bright steel, copper, brass, silver, oatmeal wall paper with gilt splashings, several styles of lithographing in colors, cotton material, aluminum and varnished wood (as of cabinets). Relative humidity 88. Temperature 55.6° F.

Result. The gas has a tendency slightly to rust polished steel. Nothing else was affected. Exposure to the gas for 5 or 6 days, even at mild concentrations will rust steel badly. If however, the liquid itself should come into contact with cotton material, it will eat holes into it in a few days' time. Especially is this noticeable after the material has been washed. The gas has little or no action on rubber.

Effects of Chloropicrin on Grain, Meal and Flour Pests.

Into cotton bags containing respectively 2,000 grams of pure wheat flour, and 1,000 grams of a mixture of flour and bran, the following insects were placed in a position about half-way through the contents of the bags: Saw toothed grain beetle (*Silvanus surinamensis*), Meal worm (*Tenebrio molitor*), Drug store beetle (*Sitodrepa panicea*), Confused flour beetle (*Tribolium confusum*), Cadelle larvæ (*Tenebroides mauritanicus*), Granary Weevil (*Calandra granaria*). Temperature 63.5° F. Relative humidity 88 to 84. Concentration 8.7 oz. per 1,000 cubic feet. Time of exposure 25 hours and 15 minutes.

Of these insects, the meal worm larvæ alone moved through the flour either up or down. In both materials, flour and the flour bran mixture, all the adult and larvæ were killed. But 58.3 per cent. of the drug store beetle pupae were still alive when their cases were opened.

Effect of Chloropicrin on Meal Worm Moth Larvæ (*Plodia interpunctella*).

A packet of Quaker Oats, very heavily infested with all stages of meal worm moth was exposed to concentration of 8.7 oz. per 1,000 cubic feet for 24 hours. Temperature 64° F. Relative humidity 86. All stages of the pest were killed.

OUR COMMON CERCOPIDAE.

Geo. A. Moore, Montreal, Que.

As no doubt some here are not familiar with the Cercopidae, or at least do not know these interesting insects by their scientific name, I will begin by telling you their common name and the interesting feature that is characteristic of the family. They are most commonly known as Spittle insects, a term given them because of the habit the nymphs or young have of making a spittle-like froth in which they live.

Many curious explanations have been made to account for this frothy substance seen upon grasses and plants, which is sometimes so thick as to cover and wet a person's boots or clothes when passing through a field or path. Superstitious fear is sometimes felt by the uneducated, who steer clear of it. Some attribute it to frogs, hence the common name "frog spittle" is given, likewise "snake spit" is used in other localities. Negroes of the South claim that horseflies are produced from such masses.

So much now for this peculiar substance, let us now get to know the insect that produces it and afterwards we can learn why it is made and how.

The Cercopidae are a family in the sub-order Homoptera of the great order Hemiptera.

The Hemiptera includes the true bugs: cicadas, treehoppers, spittle insects, lantern flies, plant lice, and scale insects; the sub-order Homoptera all the above except the true bugs.

The Homoptera can be readily divided into two groups: (1) those in which the beak clearly arises from the head and (2) those in which the beak arises apparently from between the front legs or is absent.

Our Cercopidae belong to the first group and have associated with them:

The Cicadidæ —cicadas.
The Flugoridæ—lantern flies, etc.
The Membracidæ —tree-hoppers.
The Cicadelliaæ —leaf-hoppers.

Funkhouser has given their phylogenetic rank, beginning with the lowest, as follows:

1. Cicadidæ.
2. Membracidæ.
3. Jassidæ.
5. Fulgoridœ.
5. Cercopidæ.

The Cercopidae differ from the Jassidae by having only one or two teeth instead of a row of spines on their hind tibiae. They differ from the Membracidae by not having their prothorax prolonged into a horn or point above the abdomen. They differ from the Fulgoridae by having the antennæ inserted in front of and between the eyes instead of being inserted on the sides of the cheeks beneath the eyes.

According to Uhler the Cercopidae have characteristics which mark an important advance in the direction of the higher sub-order Heteroptera. Let us itemize the important features which lead to this decision.

1. The large size of the pronotum or prothorax is in contrast to the small one in the Fulgoridae and is not a phantastic ornament like that in the Membracidae. According to Uhler it is an important regional portion, exercising various important functions.

2. The increased freedom of the anterior coxae thereby approaching a walking insect.

3. The terminal portion of the wing covers being membranous and transparent suggesting the Heteroptera.

4. The hind tibiae having only one or two short stout spines.

In some respects therefore the Cercopidae represent the highest and most specialized forms of the Homoptera, and although most students consider the Fulgoridae to be the highest and most specialized there is evidence in favor of the Cercopidae occupying the position.

So much then for their rank. They are members of a sub-order approaching the higher sub-order and exhibiting interesting links between the two.

I have not yet observed the eggs and have read but few details of what they are like. They are slightly curved and cylindrical and are said to be deposited in the stems of grasses, plants and twigs.

The Cercopidae like other Hemiptera develop gradually, undergoing a series of moults and the young exhibit the characteristics of the adult, becoming more like it at each moult or instar, of which there are five.

They most likely hibernate here both in the adult stage and in the egg.

I have taken adults on May 24th of *Lepyronia quadrangularis,* and on June 20th *Philaenus spumarius.*

It is in the nymphal stage that they live within the frothy mass mentioned above. This substance is manufactured by the newly hatched nymph and they live within it until they emerge as adults. It was formerly supposed that this was made by thrashing about of the oval end of the body in a clear viscid fluid exuded from the posterior end of the body. Prof. E. S. Morse has, however, carefully observed the operation and states that the bubbles are made as follows: the insect exudes a clear viscid fluid from the posterior end of the abdomen, after a short time the posterior end of the abdomen is extended out of the fluid and as it were, grasps a quantity of air and then it is pulled down into the fluid and, the air released, making a bubble. This is continued at the rate of seventy or eighty times a minute. The tail is moved alternately to and fro so that the bubbles are distributed around its body.

Now what is the exudate for? According to most students it is a protective covering which, even if it is conspicuous, apparently serves the creature well. It is said that wasps know that in this juicy covering there is a goodly meal for their young and that they dive in and take the unfortunate nymph to its nest to feed its offspring. However, it would appear that it protects the young Cercopid well, both from the sun and from the ravages of spiders, birds, etc.

Dr. Ball has given some interesting facts upon Cercopidae living in arid regions where many of them do not make spittle masses. He records an interesting case where the nymphs were living in a gall-like sheath in a plant enlarged enough to harbour many of them, and all living in spittle. This was in the Cow Parsnip (*Heracleum lanatum*). In these arid districts others lived on the roots and crowns of Compositae and legumes where they were protected from the hot sun and dry air.

Lintner suggests that the covering is necessary to cover the delicate-skinned nymph from the burning heat of the sun.

The Cercopidae found in Canada are as follows:

Family CERCOPIDÆ (Leach)
SUBFAMILY CERCOPINÆ (Am. and Serv.)
No species.
SUBFAMILY APHROPHORINÆ (Am. and Serv.)
Genus Aphrophora Germ.

1546. *A. quadrinotata* Say. Quebec, Ontario.
1548. *A. parallela* Say. Nova Scotia, Quebec, Ontario.
1549. *A. irrorata* Ball. British Columbia.
1551. *A. saratogensis* Fh. Nova Scotia, Ontario.
1553. *A. signoreti* Fh. Ontario.

Genus *Lepyronia* Am. and Serv.

1555. *L. quadrangularis* Say. Nova Scotia, Quebec, Ontario, Manitoba.

Genus *Philaronia*.

1558. *P. abjecta* Uhl. Manitoba.
1559. *P. bilineata* Say. Quebec, Ontario, N. W. Canada.

Genus *Philænus*.

1560. *P. leucophthalmus* Linn. Quebec, Ontario, Manitoba.
(a) Var. *falleni* V. D.
(b) Var. *ustulatus* Fall.
(c) Var. *lateralis* Linn.
(d) Var. *leucocephalus* Linn.
(e) Var. *marginellus* Fabr.
(f) Var. *fasciatus* Fabr.
(g) Var. *fabricii* Van D.
(h) Var. *pallidus* Zett.
1561. *P. lineatus* Linn. Nova Scotia, Quebec, Ontario.

Genus *Clastoptera* Germ.

1562. *C. obtusa* Say. Quebec, Ontario.
(a) Var. *achatina* Germ.
(b) Var. *testacea* Fh.
(c) Var. *tristis* V. D.
1566. *C. proteus* Fh. Quebec, Ontario.
(a) Var. *proteus* Fh.
(b) Var. *vittata* Ball.
(c) Var. *pini* Fh.

The commonest Cercopid in the Province of Quebec is *Philaenus leucophthalmus* Linn. with its hosts of varieties. This insect is found swarming in meadows and Osborn has called it the meadow Froghopper. It feeds upon the common flowers, such as the buttercup, yarrow, thistle, daisy, clover, and particularly the golden-rod.

The egg is moderately elongated, irregularly elliptic, about three times as long as broad, narrowing to one end, slightly flattened. One side straight or slightly incurved, the outer convexly curved, giving the egg a slightly curved appearance. The shell is tough and hard and developed while the eggs are still in the ovariole ducts.

They are deposited in the stalks of their food plants and pass the winter there.

The young hatch out early in the summer, during June, and after passing through five stages emerge as adults throughout July and part of August.

The nymphs are somewhat like the adults even in the earliest stages and gradually become more like it. The fifth instar is to all intents and purposes a pupal stage and in their later stages show colour and have large wing-pads.

As already mentioned this species is extremely variable, running from plain yellow to black and having varied patterns. According to Fallemand in *Genera Insectorum*, there are at least seventeen well-marked varieties, and Van Duzee lists eight as occuring in America, north of Mexico. I have at least six distinct varieties, but there are many others and the intergrading makes it difficult to separate them. Different varieties mate together and it would be interesting to breed them and see what a brood would bring forth.

The second commonest Cercopid is *Philaenus lineatus* Linn., or the Lined Spittle Hopper, or as Osborn calls it, the Grassfeeding Froghopper. This insect belongs to the same genus as does the first mentioned and has a similar life history, but feeds upon grass, timothy and red-top. This is a European species introduced into Canada. It is remarkable in that the former species is very variable, this one is constant in its form and coloring. The male is a little smaller than the female.

Aphrophora quadrinotata Say, or the Four-spotted Spittle Insect, is also common and is often found upon grape vines. They are usually taken in the adult stage during the months of July and August.

Aphrophora parallela Say, or the Parallel Spittle Insect is found quite commonly on pine trees. In reality we should designate it the Pine Froghopper as this tree is its home. There is lives in company with *A. saratogensis* Fh. It does not show the same degree of variation as does *P. leucopthalmus,* but it varies from dark to light forms.

Lepyronia quadrangularis Say, or the Angulated Froghopper is more angular in form than the others and is fairly common. It is said to feed upon grasses, weeds and the blackberry. Little variation is seen in it.

The Genus Clastoptera has two species and they are variable.

The first is *C. obtusa* Germa, or the Alder Spittle insect. This has four varieties and is common. It feeds upon the Alder.

C. proteus has three varieties. It feeds upon the dogwood, cranberry and blueberry.

They are called hoppers because of their remarkable jumping habits. They are generally found on the boughs of trees or standing on the stalks of flowers, especially the golden rod. They are very shy and when approached they slide around to the other side and they keep out of sight.

MY EXPERIENCE THIS YEAR IN DUSTING AND SPRAYING (1919).

Father Leopold, O.C.R., Oka, Que.

Your kind President, Mr. Caesar, insisted that I give you a paper this year, and I thought it would interest you to know of our work at the Oka Agricultural Institute in dusting and spraying during the past season.

The Orchard. The following remarks are limited to one of our orchards only, the most uniform we have to carry on a commercial experience in dusting and spraying: Our Wealthy orchard, situated on a gentle slope with a south-west exposure. It is not the best exposure for our Province, but we seem to get good results with this particular orchard.

I chose 30 rows of this orchard, as you can ascertain in looking over Table 1, so as to have a complete row of 11 trees separating each plot which number 6 in all, three plots sprayed and three plots dusted. Remember that the 6 plots are all in the same orchard, on the same site, the trees all the same age, 30 years old, and all the operations made on the same day. We could not get more uniform conditions, considering also that the bloom on each plot was quite uniform.

Bloom. Looking over Table I, we may see that in plot I, 4 trees only out of 44, did not bloom and 23 were in full bloom; in plot II, 10 trees did not bloom and 18 were in full bloom; in plot III, 11 did not bloom and 16 were in full bloom; in plot IV, 11 also did not bloom and 11 were in full bloom, while 18 had half to three quarter of a full bloom; in plot V, only one tree did not bloom, while 21 were in full bloom; in plot VI, 4 only did not bloom and though three only were in full bloom, 15 had from one half to three quarters of a full bloom.

Object of Experience. I insist somewhat on the fact that the greatest part of each plot had trees in bloom, as the first object I had in view, was to determine the action of liquid Lime-Sulphur on the apples in comparison with the action of liquid Bordeaux mixture on the same. I did not care what were the results as far as scab is considered, Wealthy apples not being very subject to scab.

The second object I was after was to determine just what the cost was in comparison of the dusted plots, per tree, with the sprayed plots. I have carefully gone over this in Table VIII.

I did not intend to tabulate the results of each plot separately in picking and classifying the crop, as this would have entailed too much work, for a commercial experiment. But, by going over the entire orchard, plot by plot, we had a very good idea of the results per plot.

Dusted Plots. Plots II (Table III), IV (Table V), and VI (Table VII), were dusted, with the exception of the first semi-dormant liquid spray on all except the VI's plot.

Taking up Table III we see that we used sulphur, talc and arsenate of lead in this plot, while in Table VII we see that in the last plot we substituted Hydrated Lime to the talc and arsenate of lime to the arsenate of lead and with every sort of satisfaction, thus making the last formula the most economical of all the dusted plots, as arsenate of lead is dearer than arsenate of lime.

Another interesting point was the use, for the first time in our orchards, of anhydrous Bordeaux mixture or dust Bordeaux. The arsenate of lime was used with perfect safety with this bordeaux dust. Having found the commercial copper dust too strong we reduced it by adding more hydrated lime, thus using the following formula, (Table V):

Dry Bordeaux as bought mixed already	46¼ lbs.
Hydrated Lime added to above	46¼ lbs.
Arsenate of Lime	7½ lbs.

Looking over the table of comparative costs, we can see that this new dusting material costs a little over 34½ cents per tree for the four applications, as against 33¾ cents for Sulphur-Talc-Arsenate of Lead Dusting and 17½ cents for the Sulphur-Hydrated Lime-Arsenate of Lime Dusting material

As to results on the crop, the copper dust seems to have good fungicidal value, perhaps a little better than the sulphur dusts, without any russeting to the fruit.

Sprayed Plots. I come now to the first object in view: to determine if Bordeaux mixture, as employed here in our orchards, is a superior spray than the Lime-Sulphur wash we have used since the past 10 years. In a word what the advocates of Bordeaux maintain is that Lime-Sulphur wash, far from being a beneficial spray, sprays the apples of the tree. This has not proven true at all in our orchards. In fact after we were sure that the apples in the plot sprayed with sulphur were sticking just as heavily on each tree, we had to thin each tree in plot III as in any other of the sprayed or dusted plots.

A good many visitors came to see the orchard this summer, and I may mention especially Mr. Petch, Mr. Davis and Mr. Bunting of Macdonald College. These gentlemen went over the orchard very carefully, and were convinced of the fact that Lime-Sulphur is surely a safe spray for our Province at least.

No russeting to speak of was noticed on either of the two Bordeaux mixture plots, plot I and plot V, though more Copper Sulphate was used on plot I than on plot V, the old formula of 4-4-40 being maintained on plot I and the new one of 2-10-40 on the other.

Results. Time is lacking to give too many details, but as I have mentioned before, we did not tabulate results, plot per plot, but after looking over the whole orchard, we have found that any of the formulas employed gave satisfactory results, both as to quantity and quality of the fruit. The 6 plots gave 1,500 boxes of fine apples, after they had been all thinned.

In looking over the last table of costs, dusting is certainly a more expensive way of treating an orchard than spraying; but I am going to stick to both, as both have their utility, dusting is a much quicker way to get around the trees in bad weather, and some times no results can be obtained if the applications are not made on time and thoroughly.

TABLE I.

SHOWING A COMPARISON OF THE BLOOM IN THE SIX DIFFERENT PLOTS.

I.		II.		III.		IV.		V.		VI.	
1 2 3 4	5	6 7 8 9	10	11 12 13 14	15	16 17 18 19	20	21 22 23 24	25	26 27 28 29	30
¼ 0 0 ¾		¾ 0 X 0		0 0 0 0		0 0 0 ¼		X ½ ¼ X		¾ ¼ ¼ ¼	
¼ ½ ¼ ¼		X 0 ¼ ¾		0 0 0 0		¼ 0 0 ¼		X ½ ½ ½		¼ ¼ ¼ ¼	
¼ X ½ X		¼ ¼ 0 0		X ½ ¼ ¼		¼ ½ ½ 0		¾ ¾ X X		¼ ¼ ¼ ¼	
¾ ¼ ½ ¾		¾ ¾ X X		½ X ¼ 0		0 X ¾ ¾		X X X ¾		¼ ¾ ¼ ¼	
X X ¼ X		X ½ X ¾		X 0 ½ ¼		¾ 0 X ¾		¾ ¾ ¾ ¾		0 ½ ¾ 0	
X X X X		0 X 0 X		X 0 ¼ X		X X X X		X 0 X X		X ¾ ¼ ¼	
X ¼ X X		¾ 0 X 0		X X ¼ ¾		X 0 0 ¾		X X X 0		¾ ¾ ¼ 0	
X X X X		¾ 0 X 0		X ¾ ¾ X		¾ X 0 X		X X ¾ X		¾ ¾ 0 ¼	
X X ¾ X		X X ¼ ¾		¾ ¾ X X		¾ ¾ X ¾		¾ X ¾ ¾		¾ ¾ ¼ ¼	
X X X X		X ¾ X X		X X ½ X		X ¾ ¾ ¾		¾ X X ½		X ¾ ½ X	
0 ¾ 0 X		¾ X X X		X ¼ ¾ X		¾ ¾ ¾ ¾		¾ X ½ ¾		¾ X ¾ ¼	

Explanation of signs: o, no bloom at all; x, full bloom and the fractions mean one-fourth, one-half and three-fourths of a full bloom respectively.

Each plot contains four complete rows of trees, rows 5, 10, 15, 20, 25 and 30 separating each plot.

TABLE II.

PLOT II: 39 TREES—BORDEAUX MIXTURE, 4-4-40.

Date.	Time of Applications.	Temperature.	Material.	Quantity.	Cost Material.	Cost of Labor.	Time.
May 13.	Buds quite open	Fine	Bord. mix. 4-4-40	90 gls.	$0.92¼	0.37½	30
May 26.	Buds showing pink	Fine	Bord. mix. 4-4-40	80 gls.	0.82	0.31¼	25
June 4.	After blossoms have fallen	Rain, night of 5 to 6, 6 to 7 and 7 to 8. Cloudy	Soluble sulphur, 1 lb. to ½ lb. Ars. Lime, Hyd. Lime, 5 lbs,	95 gls.	0.80¾	0.50	40
June 16.	Apples well formed	Fine	Same as above.	90 gls.	0.76½	0.37½	30

TABLE III.

DUSTED PLOT: SULPHUR, TALC, ARSENATE OF LEAD IN POWDER FORM—34 TREES.

Date.	Time of Application.	Temperature.	Material.	Quantity.	Cost of Material.	Cost of Labor.	Time taken.
May 15 .	Rain from night of 16 to 18 at night	Leaf buds well open	L.-S. 1.008 semi-dormant	90 gls.	0.59½	0.31¼	25 min.
May 26 .	Buds showing pink	Fine	Sulphur-Talc 60–40	80 lbs.	2.04	0.18¾	15 min.
June 4 ..	After blossoms have fallen	Rainy, nights of 5 to 7. Cloudy, 7 and 8	Sulphur of Talc. Arsenate of lead, 40–50–10	70 lbs.	3.62½	0.18¾	15 min.
June 17 .	Apples well formed	Fine	Same as above	80 lbs.	4.36	0.18¾	15 min.

N.B.—We put on a semi-dormant spray of lime-sulphur wash on the 15th of May.

TABLE IV.

SPRAYED PLOT: 32 TREES—LIME-SULPHUR-ARSENATE OF LEAD (POWDER).

Date.	Time of Application.	Temperature.	Material.	Quantity.	Cost of Material.	Cost of Labor.	Time taken.
May 16 .	Leaf buds well open	Rain from night of 16 to 18 at night	L.-S. 1.008 semi-dormant	80 gls.	0.53	0.37½	30 min.
May 26 .	Buds showing pink	Fine	L.-Sulphur, 1.007	70 gls.	0.37½	0.25	20 min.
June 4 .	Blossom having fallen	Rainy, nights of 5 to 7. Cloudy, 7 and 8	L.-Sulphur 1.007. Arsenate of lead, 1 lb. in 40	70 gls.	0.97	0.18¾	15 min.
June 16 .	Apples well formed	Fine	L.-S. 1.006, ½ lb. ars. of lead	80 gls.	0.42	0.25	20 min.

TABLE V.

DUSTED PLOT: ANHYDROUS BORDEAUX AND DRY ARSENATE OF CALCIUM.

Date.	Time of Application.	Temperature.	Material.	Quantity.	Cost of Material.	Cost of Labor.	Time taken.
May 16 .	Leaf buds well open	Rain from night of 16 to 18 at night	L.-S. 1.008	80 lbs.	0.53	0.37½	30 min.
May 26 .	Buds showing pink	Fine	Bordeaux dust, at 2½% metallic copper	80 lbs.	3.20	0.31¼	25 min.
June 4 .	Blossoms having fallen	Rainy nights of 5 to 7. Cloudy, 7 and 8	Dry Bordeaux, 46¼ lbs. Hydrated Lime, 46¼ Ars. Lime, 7½ lbs.	70 lbs.	3.15	0.31	25 min.
June 17 .	Apples well formed	Fine	Same formula as on June 4th	65 lbs.	2.92½	0.25	20 min.

TABLE VI.

SPRAYED PLOT: BORDEAUX MIXTURE 2-10-40 AND SOLUBLE SULPHUR—41 TREES.

Date.	Time of Application.	Weather.	Material.	Quantity.	Cost of Material.	Cost of Labor.	Time taken.
May 16 .	Leaf buds well open	Rain from nights of 16 to 18	Lime-Sul. semi-dorm., 1.008	90 gls.	0.59½	0.43¼	35 min.
May 28 .	Buds showing pink	Fine	B. mixture, 2–10–40. 2 lbs. $CuSo_4$	80 gls.	0.53	0.31¾	25 min.
June 4 .	Blossoms having fallen	Rain nights of 5 to 7. Cloudy, on 7 and 8	1 lb. solution sulphur; ½ lb. ars. of lime to 40 gls.; 5 lbs. H.L.	90 gls.	0.48	0.27½	20 min
June 16 .	Apples well formed	Fine	Same as above, ex. 1 lb. ars. lime	75 gls.	1.01¾	0.27½	20 min.

Do not use arsenate of lead with soluble sulphur. Be sure to add the hydrated lime (H.L.) to the soluble sulphur ars. of lime combination.

TABLE VII.

DUSTED PLOT: SULPHUR, HYDRATED LIME, ARSENATE OF LIME—38 TREES.
There is no semi-dormant spray in this plot. The Oka formula for dusting.

Date.	Time of Application.	Weather.	Material.	Quantity.	Cost of Material.	Cost of Labor.	Time needed.
May 26 .	Buds showing pink	Fine	Sulphur and Hydrated Lime, 60–40	80 lbs.	2.08	0.25	20 min.
June 4 .	Blossoms having fallen	Rain, nights of 5 to 6. Cloudy, 7 to 8	15 lbs. Sulphur, 5 lbs. Ars. Lime, 80 lbs. Hyd. Lime	75 lbs.	1.90¼	0.25	20 min.
June 17 .	Apples well formed	Fine	Same formula as on 4th of June	80 lbs.	2.02½	0.18¼	15 min.

We have found the above dusting formulas, omitting the semi-dormant spray in Quebec, to be the most economical dusting sprays.

TABLE VIII.

A COMPARISON OF THE COST OF THE DUSTED AND SPRAYED PLOTS.

Plot.	Material.	Labor.	Total Number.	Trees.	Cost per Tree.
I.....	$ 3.31¾	$1.56¾	$ 4.87¾	39	$0.12½
II.....	10.61	0.87½	11.48½	34	0.3378
III.....	2.29½	0.06¼	3.35¾	32	0.1049
IV.....	9.80½	1.25	11.05½	32	0.3454
V.....	2.62¼	1.30½	3.92¾	41	0.0957
VI.....	6.00¾	0.68¾	6.69½	38	0.1762

INSECT OUTBREAKS AND THEIR CAUSES.

JOHN D. TOTHILL, FREDERICTON, N.B.

The Standard Dictionary defines an outbreak as "a sudden and violent breaking forth as of something that has been pent up or restrained." This definition seems peculiarly apt for describing the biological meaning of the word because it implies that all nature is in a condition of restraint and that an outbreak is something abnormal due to the breaking of one or more restraining bonds.

Outbreaks are not confined to species of the insect world and neither are they confined to the animal kingdom. In the vegetable kingdom for instance, there are the familiar cases of the Russian thistle in Western Canada and the California Prickly Pear in Australia. There is also in our own country the case of the Northern Scrub Pine that so often comes up in pure stands after a fire has swept away the original soft wood forest. In the animal kingdom we have among insects such familar cases as the European Gipsy Moth in the New England States, the Forest Tent Caterpillars that greased the tracks and stopped some trains in Canada in 1914; the Army-Worms that at times have spoiled the Western wheat crop; and periodical outbreaks of short-horned grasshoppers. Examples of outbreaks of various species of vertebrates are also quite plentiful; there is the historical case of the European Cotton-tail Rabbit in Australia and there is the present case of the little prairie dog in Alberta. Even man himself has been known to be in a condition of biological outbreak; Caucasian Man in the 17th and 18th centuries doubled his population every twenty-five years on the North American Continent. So that outbreaks of general occurrence may be met with almost anywhere in the realm of living things.

To what causes are these outbreaks due?

As each species is held in equilibrium by the pressures of its environment it is obvious that an outbreak is due to a relaxing of one or more of these pressures.

Let us examine the cases of a few insect outbreaks the causes of which have been studied.

During the first twenty-five years of the Oyster Shell Scale's regime on this continent it increased so abundantly that men like Fitch held fears for the development of an apple industry. With the passage of the time, however, the menace of this scale insect has subsided. In the light of studies made on the present environmental conditions of this insect in Canada it seems probable that the early outbreak was due to an absence of its most effective enemy, a predaceous mite.

Turning to the Gipsy Moth I think we are more or less agreed that the New England outbreak was due more especially to an absence of natural enemies, such as the handsome Calosoma of Europe and the efficient little two-winged fly Compsilura; and also perhaps to a partial release of the food pressure.

In some of our Maritime Province cities there was last year an outbreak of the White-Marked Tussock. Mr. Dustan, who was detailed to make a study of these outbreaks, found that they were due largely to an abundant food supply: to an absence in cities of chickadees and the larger species of woodland ants; and to a relative scarcity of parasitic insects.

There is, at the present time, an outbreak of the Forest Tent insect in Alberta. Studies by Mr. Baird and myself have shown that the outbreak is due at least partially to an almost total absence of its usual insect parasites. It is also influenced perhaps by a relaxing of the food pressure or, in other words, to an increased proportion of trembling poplar.

In New Brunswick our last outbreak of the Forest Tent insect subsided suddenly in 1915. The outbreak seems to have been due to an over abundance of the poplar supply, as a direct result of civilization and forest fires.

In the case of the Spruce Budworm a study of the New Brunswick outbreak has shown the fundamental cause to be a relaxing of the normal food pressure in the form of an increased supply of balsam fir, which is the favored food plant.

This relaxing of the food pressure has been brought about by the hand of man and has been an inevitable result of existing lumbering practices.

Without going into details it can be said that the increase of balsam fir has not only meant an increased food supply, but has also meant a decreased bird supply. For the birds that under conditions of the primeval mixed type of growth keep this insect properly subdued, seldom nest or feed in pure stands of balsam fir.

In New Brunswick we now have an incipient outbreak of the Fall Webworm, and as our studies on this insect have been carried through the best part of a decade, it may be of interest to examine this case a little more closely than the others. In order to show the causes of the present outbreak let us glance for a moment at the situation obtaining toward the end of the last outbreak, and then let us follow the situation through a short term of years until the insect became almost extinct in the Province, and finally let us glance at the conditions of the present incipient outbreak.

In 1912 the Fall Webworm was abundant in New Brunswick and from the fact that the environmental pressures were then in a very nice state of equilibrium I infer that the insect had been a fairly conspicuous member of the fauna for at least a decade.

The food pressure was not very great because the staple diet is Alder and there is an abundance of this shrub along our streams and waterways; the food supply is not great enough to produce menacing millions of the insects but it is sufficient for their maintenance in a condition of mild outbreak.

On the basis of an average egg mass of 260 eggs, there were about 26 that for some reason or other failed to hatch. Of the 234 that did hatch about 42 were attacked in the young caterpillar stage by a four-winged parasite called *Apanteles*. Of the 192 left to tell the tale about 6 were attacked by another little four-winged fly *Meteorus*. Then as the larvæ grew in stature about 22 of those surviving fell prey to a fair-sized Ichneumon that is now known as a *Campoplex*. In spite of these attacks by insect parasites there were still left about 164 half-grown caterpillars. Of these about 85 were parasitized and so removed from the contest by another species of *Campoplex*. The 79 remaining larvæ became about three parts grown when a two-winged fly *Varichaeta* began an attack upon them. This fly victimised about 45 and this attack together with that of another species of minor importance reduced the inmates of our average nest to about 32. About this time the young red-eyed vireos were getting very hungry and the webworm caterpillars fell a prey to them. Of the 32 remaining these birds devoured over 90 per cent. leaving only about two in each nest. The few not attacked by birds were able to pupate, but some of them fell victims to pupal parasites of which an *Exochilum* was the most effective.

As a result of the combined environmental pressures the average number of moths yielded by each egg mass was less than two, so that in the following year there was a measurable decrease in the numbers of the webworm.

This decrease continued very regularly year after year until 1916 when the insect became almost extinct in the Province.

It is interesting to note in passing that as the species became less and less abundant the environmental pressures became so great that it was threatened with extinction. It may also be noted that as the species became rare so did its parasites until finally the red-eyed Vireos were averaging a spoil of 198 caterpillars from each web.

When the Webworm had practically disappeared from the entire Province, as represented by nine observation points, something happened that changed the whole situation. A flight of moths was blown across the Bay of Fundy and the coastal belt from St. John to Moncton was heavily seeded with the insects.

This condition enabled the species to do battle once more on favorable terms with the Vireos, and it began to increase and spread out again over the Province. It has now spread out over more than half the Province and is gaining ground rapidly.

The gain in numbers is also greatly favored because the parasites died out as the host became rare and they have not yet returned to the feast. Moreover they are not likely to return until our present outbreak becomes linked up with territory in which they now occur.

In a word then the causes of our present outbreak are, first an elimination of parasites from New Brunswick, then a flight of moths from new territory.

Having now considered a few insect outbreaks and their causes it may be remarked by way of conclusion that civilization is directly responsible for many of our more notorious outbreaks. We are increasing the food supply of particular insects and thereby making conditions favorable for outbreaks. This is not only true for the insects attacking agricultural crops but is also true for some of our forest insects. In New Brunswick we now have many square miles of forest lands supporting pure stands of poplar and these areas are the nursing grounds of our all too numerous forest tent caterpillar outbreaks. The pure stands of poplar have come in after the fires of civilization have swept away the ancient mixed growth. We also have many square miles of forest now composed of pure stands of balsam fir. In these stands has been nursed the present outbreak of Spruce Budworm—an outbreak that has swept away about three-fourths of the entire crop of merchantable fir in the Province. The overproduction of fir, as already pointed out, is a direct and necessary result of the existing methods of lumbering. In the cases of the Forest Tent insect and the Spruce Budworm civilization has had the effect of removing one of the most powerful of the restraining bonds, namely, that which under natural conditions constitutes a food pressure.

FURTHER NOTES ON THE CONTROL OF PEAR PSYLLA.

W. A. Ross and W. Robinson, Dominion Entomological Laboratory.
Vineland Station, Ontario.

With a view of securing some definite data on the susceptibility to common contact insecticides of pear psylla eggs at different stages of incubation, and in order to ascertain what spray material is the most effective ovicide, the following preliminary experiments were conducted this past year (1919).

Experiments Under Greenhouse Conditions.

During the latter part of the winter adult psyllas were taken from their hibernating quarters in the orchards and were brought into the greenhouse. There

they were placed on small pear trees—French seedlings—grown in flower pots and were then confined by means of lantern globes. The insects mated readily and deposited their eggs on the seedlings. Large numbers of eggs of known age were in this way readily secured.

Period of Incubation. The duration of incubation of the egg was obtained from the "check" experiments, which will be referred to later, and was found to vary to no considerable extent under the fairly uniform greenhouse temperatures. In fourteen out of sixteen experiments it varied from nine to eleven days. The exceptional periods of incubation were respectively eight days and twelve days.

Experiments with Contact Insecticides.

Batches of eggs, at different stages of development from newly-laid to those on the point of hatching, were sprayed by means of an atomizer with four different dilutions of lime-sulphur wash; soluble sulphur and hydrated lime; lime-sulphur and starch; and lime-sulphur and Black Leaf 40. The results were as follows:

LIME-SULPHUR WASH.

Table I—Effect of Lime-Sulphur, 1-10, 1.027 sp. gr. on Psylla Eggs.

No. of Tests made.	Total No. of Eggs.	Stage of Incubation when eggs were treated.	Average per cent. killed.	Actual per cent. killed.
2	557	Newly laid	64	70.0
2	470	4 days old	74	67.2
3	466	8 ,, ,,	67	68.8
1	414	*9 ,, ,,	74	73.4
Total.. 8	1,907			

Table II—Effect of Lime-Sulphur, 1-9, 1.029, sp. gr. on Psylla Eggs.

No. of Tests made.	Total No. of Eggs.	Stage of Incubation when eggs were treated.	Average per cent. killed.	Actual per cent. killed.
6	843	Newly laid	89	91.3
8	730	4 days old	79	78.6
6	744	8 ,, ,,	77	75.5
2	282	*9 ,, ,,	43	32.3
Total.. 22	2,599			

Table III—Effect of Lime-Sulphur, 1-8, 1.032 sp. gr. on Psylla Eggs.

No. of Tests made.	Total No. of Eggs.	Stage of Incubation when eggs were treated.	Average per cent. killed.	Actual per cent. killed.
10	679	Newly laid	99	99.7
9	593	4 days old	95	99.1
6	609	8 ,, ,,	99	99.3
5	848	9–10 ,, ,,	93	92.1
Total.. 30	2,729			

TABLE IV—EFFECT OF LIME-SULPHUR, 1-7, 1.037 SP. GR. ON PSYLLA EGGS.

No. of tests made.	Total No. of Eggs.	Stage of Incubation when eggs were treated.	Average per cent. killed.	Actual per cent. killed.
2	636	8 days old	100	100
2	635	*9–10 ,, ,,	100	100
Total.. 4	1,271			

*On the Point of Hatching.

As shown in the foregoing tables, lime-sulphur is most effective as an ovicide when used at the strength of 1-7. The tables also show that the newly-laid eggs are on the whole more readily destroyed than those on the point of hatching.

In the experiments with lime-sulphur 1-8 and 1-9 it was observed that frequently a large percentage of the eggs would hatch. However, the spraying mixtures apparently had weakened the embryos or nymphs within the eggs to such an extent that in emerging or immediately after emerging they succumbed.

In the tests where lime-sulphur 1-7 was used 100 per cent. of the eggs invariably collapsed.

LIME-SULPHUR AND STARCH.

An effort to increase the ovicidal value of the weaker lime-sulphur sprays by adding starch to them in order to make them spread and stick better met with success. (See Tables Nos. 5, 6, 7.)

TABLE V—EFFECT OF LIME-SULPHUR 1-10 PLUS 2 LBS. STARCH TO 40 GALS. ON PSYLLA EGGS.

No. of Tests. made.	Total No. of Eggs.	Stage of Incubation when eggs were treated.	Average per cent. killed.	Actual per cent. killed.
*1	364	Newly laid	100	100
2	392	4 days old	100	100
2	577	8 ,, ,,	100	100
2	438	9–10 ,, ,,	100	100
Total.. 7	1,771			

TABLE VI—EFFECT OF LIME-SULPHUR 1-9 PLUS 2 LBS. STARCH TO 40 GALS. ON PSYLLA EGGS.

No. of Tests made.	Total No. of Eggs.	Stage of Incubation when eggs were treated.	Average per cent. killed.	Actual per cent. killed.
4	588	Newly laid	100	100
*4	471	4 days old	100	100
2	251	8 ,, ,,	100	100
4	581	9–10 ,, ,,	100	100
Total.. 14	1,891			

TABLE VII—EFFECT OF LIME-SULPHUR 1-8 PLUS 2 LBS. STARCH TO 40 GALS. ON PSYLLA EGGS.

No. of Tests made.	Total No. of Eggs.	Stage of Incubation when eggs were treated.	Average per cent. killed.	Actual per cent. killed.
5	615	8 days old	99	99.6
*5	867	9–10 ,, ,,	100	100
Total.. 10	1,482			

* In some of the tests a small percentage of eggs hatched, but the nymphs, in the process of emerging or just after emerging, succumbed.

LIME-SULPHUR AND BLACK LEAF 40.

A combination of lime-sulphur 1-9 and Black Leaf 40 also proved 100 per cent. effective.

TABLE VIII—EFFECT OF LIME-SULPHUR 1-9 PLUS BLACK LEAF 40, ⅜ PT. TO 40 GALS. ON PSYLLA EGGS.

No. of Tests made.	Total No. of Eggs.	Stage of Incubation when eggs were treated.	Average per cent. killed.	Actual per cent. killed.
2	435	Newly laid	100	100
*1	540	4 days old	100	100
*1	558	8 ,, ,,	100	100
1	485	9 ,, ,,	100	100
Total.. 5	2,018			

* In these cases a small percentage of eggs hatched, but the nymphs, in the process of emerging or just after emerging, succumbed.

SOLUBLE SULPHUR AND HYDRATED LIME.

In using soluble sulphur, hydrated lime was added to the spray primarily to prevent injury to the bursting buds.

TABLE IX—EFFECT OF SOLUBLE SULPHUR, 12½ LBS., HYDRATED LIME, 10 LBS., TO 40 GALS. ON PSYLLA EGGS.

No. of Tests made.	Total No. of Eggs.	Stage of Incubation when eggs were laid.	Average per cent. killed.	Actual per cent. killed.
3	796	Newly laid	100	100
2	700	4 days old	100	100
2	845	8 ,, ,,	100	100
2	500	9 ,, ,,	100	100
Total.. 9	2,841			

Checks. Sixteen batches of eggs were left untreated at various times while the foregoing experiments were being conducted. These served as checks. Out of a total of 1,346 eggs, 93 per cent. hatched.

Effects on Nymphs. The few tests which were made with lime-sulphur, etc., on recently hatched nymphs were sufficient to show that 1st and 2nd instar nymphs are readily destroyed by lime-sulphur 1-8 and 1-9, with or without starch.

Table X—Effect of Spray Mixtures on Recently Hatched Psylla Nymphs.

Treatment.	No. of Tests made.	Total No. of Nymphs.	Instar.	Average per cent. killed.	Actual per cent. killed.
Lime-Sulphur, 1-8	2	47	1st	100	100
	2	107	2nd	100	100
Lime-Sulphur, 1-9	3	371	1st	98	95.2
	2	88	2nd	100	100
Lime-Sulphur, 1-9 Starch, 2 lbs. to 40	1	85	1st	100	100
Lime-Sulphur, 1-10	1	85	1st	91	91
Lime-Sulphur, 1 to 10 Starch, 2 lbs. to 40	1	271	1st	96	96
Total	12	1,054			

Orchard Experiments.

S. M. Culp's Orchard. Our orchard experiments on the control of psylla were conducted at Beamsville in S. M. Culp's thirteen-acre orchard of Bartlett, Duchess, Kieffer, Flemish Beauty, Bosc, Winter Nelis and Anjou pears. The mild winter of 1918-19 was very favorable for the hibernating adults and in the spring they emerged in large numbers and a large deposition of eggs was made.

First Application. The first application, i.e. the application to destroy the eggs, was put on by means of a spray gun at the usual time,* and the following spray mixtures were used:

(1) Lime-sulphur 1-7
Lime-sulphur 1-9
(2) Starch 2 lbs. to 40 gallons
(3) Lime-sulphur 1-10
Starch 2 lbs. to 40 gallons
(4) Soluble sulphur 12½ lbs.
Hydrated lime 10 lbs.
Water 40 gals.

No one spray mixture, so far as we could judge, proved superior to the others. Each destroyed practically all the eggs and exposed nymphs. The nymphs which had hatched out before the sprays were applied and had sought shelter in the leaf buds beneath the bud scales were uninjured. These averaged about 1.5 to a leaf-bud on all varieties other than Kieffer. On the Kieffer trees the infestation was about .18 to a leaf cluster. This difference no doubt was due to the fact that the Kieffer trees were out in leaf when the spray was applied and therefore did not afford the nymphs much protection.

* The Pear Psylla in Ontario—Report of the Ent. Soc. of Ont., 1918, pp. 81-90.

All the spraying mixtures injured the buds and foliage to a slight but not appreciable extent. In comparing the Culp orchard with pear trees which had been sprayed with lime-sulphur 1-20, no difference in the amount of "burning" was noticed.

Spraying for the Nymphs. In order to destroy the nymphs which had escaped the first spray and those which had hatched from the eggs of belated females, a second application was made after the blossoms fell. Black Leaf 40, 3/8 pint to 40 gallons, was added to the regular codling moth spray (Lime-sulphur 1-40, arsenate of lead 2½ lbs. to 40) and this was applied with great thoroughness.

This application gave excellent results. When the orchard was examined a few days later only an old psylla was found. The insect increased very slowly in numbers throughout the season and right up to early September its numbers were very insignificant. The foliage was in beautiful condition all season and the trees bore an excellent crop of pears.

W. F. W. Fisher's Orchard. Part of a large pear orchard at Burlington was sprayed at the usual time for the "egg spray," with lime-sulphur wash 1-9 and starch 2 lbs. to 40 gallons and the other and smaller part was sprayed with lime-sulphur 1-7. In addition to this all the trees received the post-blossom application of Black Leaf 40.

Results. Excellent results were secured—the psylla was reduced to very insignificant proportions, and for the first time in many years caused no damage.

EVENING SESSION.

The Evening Meeting was held at 8 p.m. in the Carnegie Library and was well attended by members and others interested. The chair was occupied by the Deputy Minister of Agriculture, Mr. J. H. Grisdale. The Popular Address was given by Mr. C. L. Marlatt, Chairman of the Federal Horticultural Board, Washington, D.C., his subject being "The Federal Plant Quarantine Act" or "How the United States is Preventing the Introduction of Foreign Insect Pests and Plant Diseases." The address was highly appreciated and felt to be of special value to Canadian Entomologists, as was pointed out by the President of the Society, Prof. Lawson Caesar, while proposing a vote of thanks.

THE FEDERAL PLANT QUARANTINE ACT.

C. L. Marlatt, Chairman, Federal Horticultural Board, Washington, D.C.

[The following discussion covers the subject in a general way as it was presented extemporaneously.]

Most of you undoubtedly are familiar with the Federal Plant Quarantine Act and with the general features of its administration through a Federal Horticultural Board. This Act was the outcome of a long, hard fight which began twenty years ago as a result of a nation-wide conference called in Washington. This conference included state entomologists and inspectors and secretaries of agriculture and horticulture and other persons interested in plant protection. The need of a federal quarantine which should give protection to the whole United

States had long been felt. The San José Scale excitement of that period was, however, the leading element in bringing about the demand for a federal plant law. As a result of the conference in Washington a broad plant law was drafted which was intended to regulate both foreign importation of plants and also interstate traffic. On account of its breadth of field this proposed law aroused a good deal of opposition and failed to get any real standing before Congress. It was re-introduced at different sessions of Congress for a number of years but never received effective support

In 1908 and 1909 the plant import situation became very serious on account of the sudden increase of infestation of nursery stock received from Europe and Japan by gipsy and brown-tail moths. This was about eight years after the original attempt to get federal plant quarantine law. The failure up to that time to get Congress to act had rather dispelled the enthusiasm of most of us, and the passage of any satisfactory law through Congress was generally looked upon as being practically impossible. The securing of legislation, giving new federal powers, is always a difficult matter and especially so where such powers involve an entirely new subject of legislation encroaching in any degree on the police or other powers of the states.

In the face of the great danger which this country was under from the character of nursery stock importations of 1908-09 I secured permission from the Secretary of Agriculture to draft a new plant quarantine law and to have it introduced in Congress. That draft was the original of the present plant quarantine act. It was a very difficult matter to get this legislation through Congress. The bill was revised and re-introduced many times before it was finally passed in August, 1912, and the story of the long fight to get this legislation would be a very interesting one if I had time to relate it.

The Federal Plant Quarantine Act of 1912 is limited to control of entry of foreign plants and plant products, and to the establishment of domestic quarantines within the United States controlling interstate movement of such quarantined or restricted plants or plant products. As to its foreign features, all plants or plant products of whatever kind are subject to restriction. As to the domestic and interstate features, not only plants and plant products may be restricted but any other article which may be the means of conveying insect or disease enemies of plants, a control broad enough to cover, for example, stone and other quarry products, earth, or even manufactured articles. The law does not provide for any general interstate control of plant traffic except in relation to specific quarantines to prevent the spread of dangerous insects or plant diseases, and in this respect is less broad than the law drafted by the original conference at Washington referred to at the outset of this discussion.

This quarantine act has now been in force seven years. There are now in force under it some fifteen foreign quarantines and seven orders restricting or regulating the entry of plants and plant products and some twelve domestic quarantines. With most of this quarantine and control action you are doubtless fairly familiar. I will discuss rather briefly a few of the more important activities of the Board in respect to these quarantines and restrictions on plant movement.

Perhaps the most important activity of the Board at the moment is in relation to the pink bollworm of cotton. This insect is a very important new enemy of cotton which has recently obtained foothold in Mexico and also scant foothold in Texas. To prevent the further entry of this insect into the United States and to effect its control in the limited areas where it is now established we are now

receiving from Congress an annual appropriation of upwards of half a million dollars. The work involved covers a very wide range, including extensive clean-up operations in Texas, the enforcement of a quarantine service between Mexico and the United States, the control of all import cotton into the United States and of the cotton mills in this country which make use of such import cotton, and also the control of cottonseed cake and meal and any other product relating to cotton which may be a means of introducing the insect.

Another important quarantine feature under the Board is the white pine blister rust quarantine, which has for its special object the protection of the great pine areas of the western half of the United States from infestation from the eastern half of the United States where this disease has gained wide and probably firm foothold.

One of the later quarantines has relation to the European borer which has recently obtained foothold in the neighborhood of Boston and in a limited area near Albany, N. Y. We are asking Congress for an appropriation of $500,000 for quarantine and other control work in relation to this borer. Inasmuch as this insect is known to infest practically all succulent vegetation, even grasses, and is so concealed as to make its discovery difficult, its extermination is recognized as an impossibility, but if it cannot be exterminated, it certainly can be controlled. I do not believe in being unnecessarily alarmed over the introduction of any new pest, and in the case of this new corn borer, the last year's experience has demonstrated that there are at least four important controlling factors which may later on show this pest to be a comparatively unimportant one, certainly indicating that Canada, for example, need have very little fear on account of it. These hopeful or controlling factors are: (1) for the northern areas of corn culture, single-broodedness with accompanying negligible damage indicated; (2) possibility of cultural control by the elimination of weeds; (3) the immunity now indicated for ordinary field corn, and (4) the possibility of effective egg parasitism.

(The introduction of this insect through the agency of imported broom corn and its probable wide dissemination in the United States was discussed in some detail.)

Another problem that has recently come up to the Board is the potato wart disease, one of the three plant enemies specifically mentioned in the Federal Quarantine Act to be immediately guarded against. This disease was evidently brought into this country in the winter and spring of 1911-12 before the Quarantine Act was passed. The Department of Agriculture through the Federal Horticultural Board is co-operating with the State of Pennsylvania in a thoroughgoing campaign to eradicate this pest. The work of the last season, now concluded, has presented a very much more hopeful outlook also with respect to this potato disease. In other words, the principal commercial varieties of potatoes grown in the United States have developed a substantial immunity to this disease and it looks very possible, therefore, that it can be controlled through the growth of these immune varieties and other varieties, the immunity of which has already been demonstrated in European countries.

These are a few of the important subjects which the Board now has under way. Other subjects are the Oriental fruit or peach moth which came from Japan on ornamental cherry stock and has obtained rather wide foothold in the District of Columbia, Maryland and Virginia and also in New York and a few other places. This pest might have come to this country on any shipment of Japanese ornamental cherry or peach stock, but apparently obtained its first foothold through a ship-

ment of cherry trees made as a gift of the City of Tokio of Japan to the City of Washington. The first lot was of large sized trees and so seriously infested with various insects that the trees were burned. A second sending was later made of young trees and these were apparently in a fairly healthy condition and at least had been so pruned back that any evidences of the work of this insect had been entirely removed. Incidentally, it may be said that it is a very difficult matter to detect an insect about which you know nothing and which you are not anticipating. The inspector does not know where to look for it. In the case of this pest, even with full knowledge of its habits, it is a very difficult insect to detect by inspection, so carefully concealed is it in its hibernating situation. This infestation was not discovered at the time and the trees were planted in Washington's Riverside Park. The local infestation of the District of Columbia and adjacent Maryland and Virginia has undoubtedly originated from this importation of flowering Japanese cherries. The incident illustrates the futility of inspection, even when carefully conducted, as a means of detecting unknown or unfamiliar pests and is one of the strong arguments for the more radical quarantine action which the Board has recently taken in respect to all such ornamental and nursery stock.

Another pest recently imported is the so-called Japanese beetle. It was introduced apparently about eight years ago on iris stock imported by the Dreer nurseries. It now has a very strong foothold in a comparatively small area in New Jersey opposite Philadelphia. This insect lives nine months of the year in the ground out of sight, is a strong flier, feeds miscellaneously on all sorts of vegetation, and there is therefore very little likelihood that it can ever be exterminated. By federal and state appropriation, however, a strong effort is being made to control this insect and to demonstrate the possibilities of exterminating it if such possibilities exist.

One of the last, and perhaps one of the worst, plant pests that has turned up in this country is the "take-all" disease of wheat which has recently been determined in a few fields in southern Illinois and in a similarly small area in Indiana. War conditions and food shortage led to a movement looking to the importation of wheat from Australia into the United States to replace American-grown wheat which was being exported to meet European needs. A knowledge of the risk from such Australian wheat led the Board to declare a federal quarantine and to place such restrictions as to disinfection and use of such wheat as to safeguard its entry. While these steps were in progress this disease was discovered in a small area in southern Illinois and later in a small area in Indiana. The method of entry of this disease is unknown and nothing has been found to indicate that it came with any wheat imported from Australia for commercial purposes. It is probable that its entry was due to some experimental importation of Australian wheat. Very energetic action was undertaken in cooperation with the two states concerned to stamp out the disease in the infected areas, including the prohibition of the further growth of wheat in such areas and the disinfection of the grain and the burning of infected straw and stubble.

These seven or eight quarantine subjects which I have mentioned, together with the nursery stock quarantine, are the big items of work which the Federal Horticultural Board has under way at the present time.

I will close with a brief discussion of the nursery stock, seed and plant quarantine, a subject which has perhaps as great interest for you as any of these others and is one of the oldest of our lines of work. This quarantine has been adminis-

tered since the passage of the Act in 1912, but has been revised under what is known as Quarantine No. 37. For seven years the Board had been endeavoring to prevent the entry of pests with imported nursery stock and other plants and seeds by a system of foreign inspection and certification with re-inspection of imported goods at destination in this country. Under this system all foreign countries wishing to engage in plant traffic with the United States on a commercial scale have been required to establish an adequate inspection and certification service. Practically all of the important countries of the world have now established such service in response to the demands of the plant quarantine act of the United States. The benefit of this service, as evidenced in the character of the plant shipments to this country, has been tremendous. Whereas, before these inspection and certification measures were compelled by our act, thousands of instances of browntail moth and gipsy moth infestations occurred in a single year in our plant imports, there are now comparatively few instances of these pests being found. Freedom from all kinds of insect pests and plant diseases has been very marked as compared with the old conditions, but, after all, it is only a *marked* improvement, not absolute freedom. These pests still come in. For example, sixty-three instances of browntail and gipsy moth infestations have been discovered by the inspection service in the seven years since the act went into effect, and it is unfortunately not at all certain that all infestations by these insects were discovered in re-inspection at destination in this country. Hundreds of other pests have also been discovered as a result of these inspections. This state of affairs was the important reason leading to the enactment of a new nursery stock, plant and seed quarantine, namely, Quarantine Order No. 37. Before this quarantine was promulgated the subject was given long and careful consideration. A thoroughgoing investigation was inaugurated by the Board, bringing into its scope all the departmental plant experts of its various bureaus. The matter had also been under consideration for several years by state men through their organizations. Finally the whole subject was discussed fully at a hearing at which the producing horticulturists and the state experts of the whole country were brought together. This discussion indicated a practically unanimous support of a quarantine which had been outlined and which was substantially the same in scope as Quarantine No. 37.

Following this hearing the matter was given further study by our experts and some of these experts visited producing horticultural establishments of this country to discuss the needs of this country as to plant importations. Some months later a final conference was called of all the interests concerned and to this conference was submitted a provisional draft of the quarantine. It was eight months after the quarantine had been first broached that it was finally promulgated. The action of the department and the Board, therefore, can certainly not be charged with having been precipitant. The quarantine became effective June 1st, 1919. It has aroused a wide criticism and protest, much of this protest being based on misrepresentation. It has been represented, for example, that the quarantine will prevent the entry into the United States of new plant creations of Europe and other foreign countries and that America will be forever deprived of all such additions to its horticulture and floriculture. There is no foundation for this charge. The quarantine does not really prevent the importation of any plants into the United Satates for which a real need can be shown. Provision is made in the quarantine for the entry for introduction purposes of any new plant creations of Europe or other foreign countries. Furthermore, the quarantine provides for the entry of any reasonable amount of plant material not available in the United

States which is needed for the development of reproduction enterprises to supply home needs. All such special introductions, however, must be made through the Department of Agriculture and will be subject to all the safeguards which the highly developed inspection service of the Department in Washington can give, including, if necessary, detention in quarantine or even the destruction of the imported material if its condition of infestation is such that such destruction is determined as necessary to prevent entry of pests or plant diseases. It is not probable, however, that material offered for entry under this provision of the quarantine will be often so infested as to require such drastic action. As a result of the misrepresentation referred to and other phases of misrepresentation Congress and the Department of Agriculture at Washington have been flooded with letters and petitions in opposition to the quarantine. This opposition has largely come from certain importing interests which will be necessarily restricted in business by the quarantine.

The experts of the Department of Agriculture, and, I think, also the thoughtful horticultural interests of the country, are convinced of the need of such quarantine action. Undoubtedly this quarantine will lead to a development in this country of horticultural productions to take the place of the articles which have hitherto been obtained from foreign sources. In this way it will indirectly be the means of developing American horticulture and floriculture. It is only fair to say to those who go into production enterprises to supply the material the importation of which has been cut off that this quarantine in all probability in its main lines will stand and that such enterprises will therefore fill a permanent place in our horticulture. This does not mean that Quarantine No. 37 is not subject to modification or change, but it does mean that the department and the experts of the country are convinced that it is sound in principle and that its enforcement practically along its present lines will afford a needed protection for the forest, fruit and farm interests of this country. Wherever an error can be shown it will be corrected but changes will not be made for personal, selfish, or commercial interests, however powerful their backing, to the loss of the principle of protection which underlies and is the basis for this quarantine.

HOPKINS' BIOCLIMATIC LAW.

Wm. Lochhead, Macdonald College, Que.

Economic Entomology is ever drawing on other sciences for aid in the solution of its problems. It is indebted to chemistry for help in solving the problem of insecticides, to bacteriology and botany in the effort to work out means of controlling certain insects by bacteria and fungi, to agriculture for the introduction of farm practices that tend to control certain insects, to zoology for a knowledge of the habits of birds and other animals that feed upon insects; to physics for suggestions and explanations regarding the construction of many useful devices, and to Meteorology for the help it has given toward a better understanding of the distribution of organic life and of the factors that influence its seasonal activities. Without a knowledge of these sciences an economic entomologist may make but little headway when brought face to face with a new practical problem.

One of the most recent and most far-reaching contributions to Economic Entomology is the Bioclimatic Law of Dr. Hopkins of the U. S. Bureau of Entomology.

The Science of Phenology. From time immemorial agricultural practice has been guided by meteorological factors. Primitive man, no doubt, soon discovered that his food plants required a limited period to reach maturity and that every growing season had its earliest and latest dates for planting. He soon learned, too, that these dates varied with different regions, with different seasons, and with local weather conditions. In the course of time a mass of observations accumulated, which constituted the basis of farm practice. Naturally much error crept into the observations and false deductions were drawn from certain coincidences, but on the whole the early growers of plants were guided by experience. Their contact with nature was very intimate, perhaps more intimate than that of the farmers of to-day. They knew the times of opening of the buds of the various shrubs and trees, and of the arrival and departure of the birds, and learned to associate certain farm practices with these events as natural guides.

For example, the time of the appearance of the blossoms on the maple was considered by many people a suitable time to begin gardening; the blossoming of blackberries the best time for bean planting; the blooming of the locust trees for the planting of cotton; the mouse-ear size of white oak or maple leaves for the planting of corn; the opening of the elder flowers for the sowing of turnip seed; the ripening of the elder berries for the harvesting of the early onions; and the ripening of the burs of the small cockle-bur for the harvesting of the late crops. In other words, the early farmers associated their farming operations with periodic phenomena connected with some tree, shrub or plant.

In the eighteenth century when plants began to be studied scientifically attention was given to the recording of observations on such periodic phenomena as the opening of the buds, the time of flowering, the ripening of the seeds, etc., which give rise to the science of phenology. At the same time studies were made to determine the geographical distribution of plants and animals.

In the course of these investigations the rates of variation in the dates were partially determined for different latitude, longitude and altitude, but the number of data was not sufficient to permit a definite law of variation to be formulated.

It was early observed that while temperature was the main controlling factor in bringing about variations in periodic phenomena other factors also played an important part. Dr. Merriam's maps of the zonal distribution of plants and animals into Life Zones were largely based on the temperature factor and are very suggestive and helpful in matters of life distribution. These maps, however, do not furnish information regarding the dates of periodic phenomena in different regions and districts so much desired by the economic biologist in the matter of application of methods of control in the different regions.

As an example, the old spraying calendars, based on regional distribution rather than phenological phenomena, have been discarded as unsatisfactory, and instead "some periodic event in the plant to which the spray is to be applied is given as the index to the time to do the work."

Dr. A. D. Hopkins was the first person in America, I believe, who attempted to apply this science of phenology to the solution of entomological problems, especially those relating to certain forest insects in West Virginia. Later it was applied in connection with the control of the Hessian Fly, and as an outcome of the investigations a definite Bioclimatic Law was formulated, which forms a working guide for farm practice and biological research over the entire continent. In connection with this law Dr. Hopkins has prepared a system of maps and com-

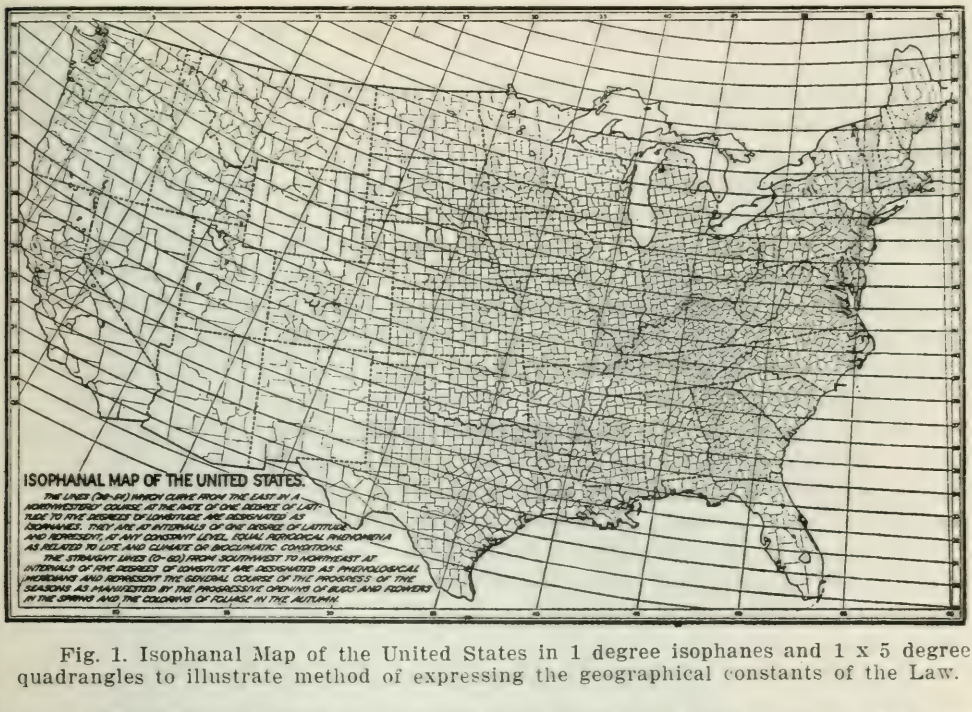


Fig. 1. Isophanal Map of the United States in 1 degree isophanes and 1 x 5 degree quadrangles to illustrate method of expressing the geographical constants of the Law.

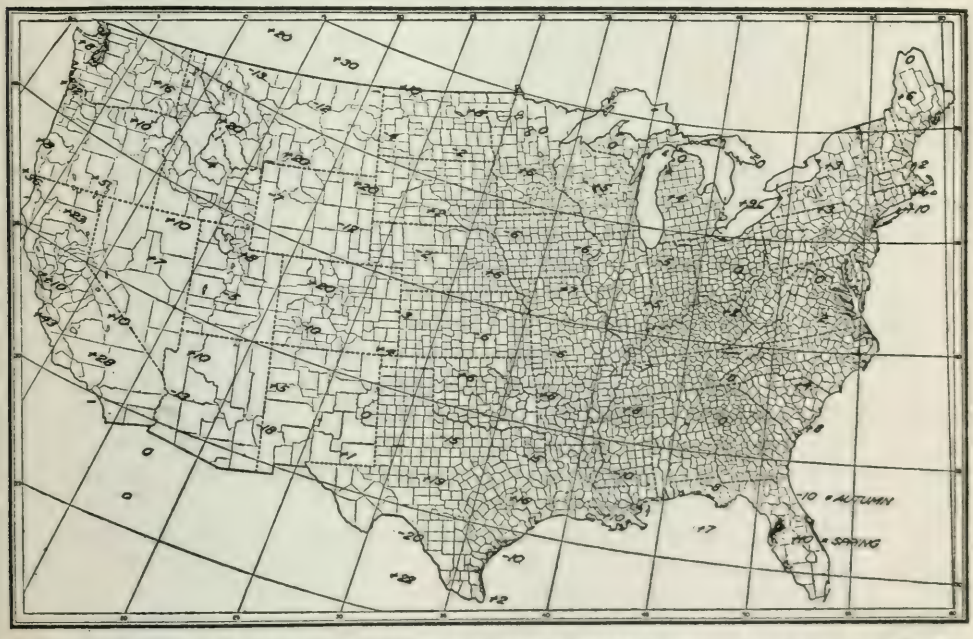


Fig. 2. Isophanal Map of the United States in 5 degree isophanes and 5 x 5 degree quadrangles to illustrate method of designating phenological areas for the study of influences which contribute to time, altitude or latitude departures from the geographical constants. The estimated minus (earlier) and plus (later) departures in days from the computed time constant for spring and autumn events, as given for each quadrangle, are based on a study of more than 40,000 reports on the date wheat harvest begins and on other statistics of planting and harvest dates for wheat, potatoes, etc., and represent averages for the entire quadrangle.

puting calendars and tables which aid very much in the computation of phenological dates.

Dr. Hopkins informs us that the rates of variation in the dates of periodic events were determined earlier by Schubler in 1830 for the distance between Parma, Italy, and Greifswald, Prussia, as 4 days for a difference of about 325 feet of altitude and 1 degree of latitude. Although Quetelet, in 1846, was aware of the influence of longitude, it remained for Fritsch, in 1865, to state that each degree of longitude westward made a variation of 4/10 of a day. In 1893 Ihne found the variation to be about 9/10 of a day. Dr. Hopkins, in 1900, concluded from his investigations in West Virginia that the rate of variation was 4 days to 1 degree of latitude and 400 feet of altitude, and later in 1915 concluded that there was a variation of 4 days to 5 degrees of longitude.

The Bioclimatic Law. The Bioclimatic Law may be stated as follows: *The variation in the time in which periodical events occur in the seasonal development and habits of plants and animals at different geographical positions within the range of their distribution is, other things being equal, at the rate of four days for each degree of latitude, five degrees of longitude, or 400 feet of altitude.*

According to this law, lines running from the east toward the north-west at the rate of one degree of latitude to five degrees of longitude represent the same constant or average date of periodical phenomenon for any given level throughout their length. Such lines are called *isophanal lines,* and in accordance with this law Dr. Hopkins has constructed isophanal maps of the United States (Fig. 1). Meridian lines drawn at right angles to the isophanal lines are called *phenological meridians.*

The influence of certain local factors that modify the average dates of the periodic phenomena for each quadrangle, such as topography, lakes, large rivers, rainfall, sunshine, etc., according to their intensity, is marked on each quadrangle as plus (later) or minus (earlier) departures for both spring and autumn (Fig. 2).

Dr. Hopkins believes that the amount of departure of the actual from the computed date for any locality represents the intensity of the action of local factors.

For example, in Florida the departures are ten days earlier than computed time for autumn and ten days later for spring events; for Western Ontario only nine days later for autumn. Such departures were based on a study of more than 40,000 reports on the date wheat harvest begins.

The departure constants were obtained by establishing *phenological bases* or "localities where a sufficient number of observations have been made to establish corrections for local and regional influences, so that the date of any seasonal event recorded there may serve as a reliable basis for the computation of corresponding dates for the same event at any other geographical position within the same or different regions of a country or continent."

Wooster, Ohio, was taken as the base for fall wheat seeding on account of the thorough work done there by Webster in connection with the determination of Hessian fly-free dates, while Minnesota was taken as the base for spring wheat seeding.

In accordance with the law and with the amount of departures for different localities Dr. Hopkins, in 1917, proposed to the U. S. Department of Agriculture to make wheat seeding map-calendars for all the States for the purpose of increasing the wheat yields for 1918 by the control of the Hessian Fly. On account of the limited time, however, posters with maps and instructions were prepared for only New York, Pennsylvania, Illinois, Indiana, Nebraska, New

Jersey, West Virginia, Oklahoma, Virginia, North Carolina, and Tennessee. (Fig. 3.)

Fig. 3 is a calendar of winter wheat seeding date constants for map (Fig. 1) computed for latitude, longitude and altitude. To illustrate its use let us select the Guelph region. This lies in the quadrangle bounded by the phenological meridians 45 and 50 and the isophanes 47 and 48 and at an altitude of 1,000 feet. By referring to Fig. 3 it will be seen that the date for winter wheat seeding is September 10th for an altitude of 1,000 feet. Next, by referring to Fig. 2 we find

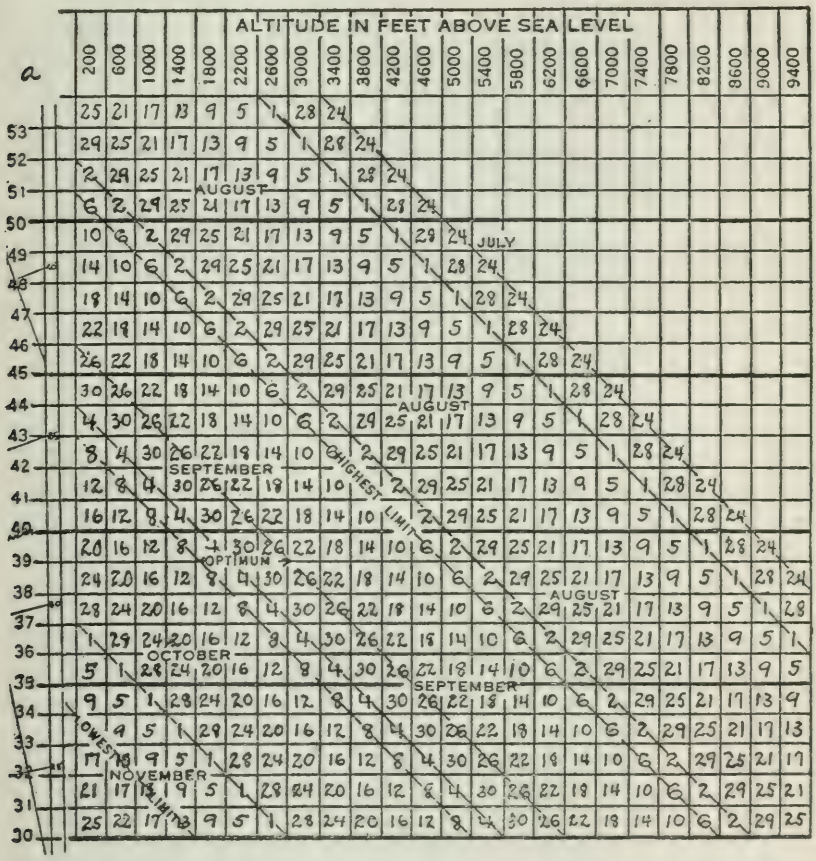


Fig. 3. Calendar of wheat seeding date constants for Isophanal Map, Fig. 1. *a* Isophanes. The dates in this calendar are the computed constants for the given altitudes to be corrected for the 5 x 5 quadrangles of Fig. 2, by adding the + and subtracting the —autumn date which will give the general average date for the average altitude and average season.

the departure constants are 0 for fall events. For this locality, therefore, the best date for winter wheat seeding is September 10th.

It is impossible in the short time allotted me for the presentation of this paper to give in detail the many interesting studies made by Dr. Hopkins in the formulation of his Bioclimatic Law. Such details will be found in *Supplement No. 9 of the Monthly Weather Review*, issued May 1st, 1918, and in an article in the June, 1919, number of the *Scientific Monthly*.

It seems to me that Dr. Hopkins' Bioclimatic Law is an important contribution to service inasmuch as it is based on phenological phenomena which are the best means of determining the influence of all the complex factors that play upon plant and animal life.

I have already referred to the use of the Law in the control of the Hessian Fly. Dr. Hopkins has used it in connection with certain forest insects, viz., the Southern Pine Beetle (*Dendroctonus frontalis*), the Western Pine Beetle (*D. brevicomis*), the Mountain Pine Beetle (*D. monticolae*), and the Pine Bark Louse or Spruce Gall Louse (*Pineus strobi*).

By means of a map-calendar the dates for the beginning and ending of control measures between the autumn and spring flights can be recommended, in the case of the Pine Beetles, and in the case of the Pine Bark Louse the date of hatching and time of moving about.

Dr. Hopkins believes that the Law can be applied with great advantage in farm practice as a means of determining the dates of best seeding and harvesting for the production of maximum crops. While he has shown the application of the Law to winter and spring wheat he is of the opinion that it can be applied equally well to all kinds of crops.

Moreover, it can be used for the making of reliable spray calendars in orchard practice for the control of insect and fungus diseases.

This Law, moreover, is of value in determining the northern limit in the geographical distribution of species of plants and animals. It is, therefore, a valuable supplement to Merriam's work on Life Zones.

Regarding the value of phenology Dr. Hopkins says: "Properly recorded and correctly interpreted there is nothing perhaps to equal the records of the dates of periodical events in plants and animals as indices to the bioclimatic character of a place or local area, because such events are in direct response, not to one or a few, but to all the complex elements and factors of the environment which no artificial instrument or set of instruments yet available will record. In other words, while species and varieties and even individuals of the same species and variety respond in a more or less different degree to the same complex influences, there are certain constant elements in the response of individuals and groups of varieties and species which, if properly interpreted, will serve as a key to the bioclimatic character and conditions which distinguish a particular region, locality, or place from that of other nearby or distant ones.

The Bioclimatic Law in Canada.

Most of the data from which Dr. Hopkins prepared his maps were obtained from the United States, and it will be observed that the departures from the Law constants are practically absent from the Canadian section of his maps. No doubt the reason for this absence was the lack of sufficient data from Canada.

The writer believes, however, that Canada has the data if they can only be compiled. This country has not only a large number of experiment stations scattered from the Atlantic to the Pacific, but also a large number of reports prepared by Federal and Provincial agencies, that could supply the necessary data relating to phenological phenomena. A compilation of such data would be most valuable in extending the practical application of the Bioclimatic Law to the different sections of Canada. The writer expresses the hope that some competent

government official may be detailed to gather such data, so that Canada may reap the advantages which may flow from the application of the Law to agricultural practice and to the solution of many entomological and other problems.

FRIDAY MORNING, 9 O'CLOCK.

LOCUSTS IN MANITOBA, WITH SPECIAL REFERENCE TO THE OUTBREAK OF 1919.

Norman Criddle, Dominion Entomological Laboratory, Treesbank, Man.

We have had locust plagues in the Prairie Provinces as far back as history will take us; that they occurred long before that time is extremely probable. There were, however, no crops in those days and very few observers, consequently the locust outbreaks were imperfectly recorded and our knowledge of the species involved is extremely dubious. There were at least seven distinct locust outbreaks in the Nineteenth Century most of which extended over two or more years. The first was recorded from Lord Selkirk Red River colony in 1818, another probably occurred about 1830; then we have records for: 1855-57, 1864-66, 1868-70, 1872-75, 1897-98, and 1900 to 1904 of the new century. In other words there were fully 22 locust years in the last hundred. Another significant point is that in almost every instance the infestation lasted two or more years.

Reading from Riley, and from Lugger of Minnesota, one notes that by far the most important injury in all their records was attributed to the Migratory locust, *Melanoplus spretis,* a species which was supposed to have its permanent abode in the foothills of the Rocky Mountains and from that breeding ground to spread far over the surrounding country. In his later reports Lugger also attributes much to the Lesser Migratory locust, *M. atlanis,* and in a smaller extent to the Pellucid locust, *Camnula pellucida.* Judging from more recent occurrences I think it would be safe in concluding that these latter species were present in most of the former outbreaks, especially the Lesser Migratory locust which is, after all, very like *spretis.*

It is evident from this brief summary of the past, that we can expect locusts to become troublesome at intervals of about 15 years though these periodic visits are not, of course, by any means regular. The insect's appearance depends largely upon meteorological conditions among the most important of which are abnormally dry seasons, especially during May and June. There is one other point to bear in mind and that is while we talk of a locust outbreak every 15 years we should remember that such an invasion does not necessarily cover the whole country because, as a rule, it is far from doing so. Indeed most of our outbreaks have been confined to the southern portion of the province.

My personal experience with locusts dates back to 1900, when we had an outbreak in our neighbourhood involving our own farm among the rest. The species concerned was chiefly *atlanis* though there were a fair number of *spretis* among them for the first two years, after which that species disappeared and has not, so far as I am aware, been heard of since. Much crop was destroyed the first season owing to lack of knowledge and proper equipment. The second year, however, we learned the merits of poisoned baits and from that time forward the comparatively small losses were due almost entirely to neglect.

It is fourteen years since the events I have just recorded took place and during the interval we have been free from locusts in the province. The present year, however, has once more brought the insects into prominence.

The new outbreak is a serious one and promises to become still more so. Fully half a million acres are already involved in the southern portion of Manitoba, while there are several areas of lesser extent isolated from the rest.

Strange as it may seem this severe outbreak came to us as a complete surprise, not a report came in of injury the previous year though we know that the insects must have been present in large numbers. This shows how little one can rely upon farmers for such information and indicates how necessary it is to have reliable scouts to be on the watch for just such a plague. The savings from such observers, on this year alone, would have been sufficient to pay the salaries of half a dozen scouts for the next ten years. When information did reach us the young hoppers were already beyond immediate control, and when I arrived at the infested area whole fields had been swept bare; added to this was the fact that we were totally unprepared and in consequence all the necessary supplies were lacking. It was a week before poison could be shipped into the affected territory, and even then it could not be secured in anything like sufficient quantity to cope with the outbreak. The Winnipeg labor strike was partly to blame for this and it also greatly hampered transportation when the supplies were shipped from the east. These are a few of the first difficulties we had to contend against. Next we had to educate the farmers as to the means of control and this in itself was no simple task. Most of the farmers involved had never witnessed a locust outbreak before and when they saw the millions upon millions of tiny hoppers turning the green fields black, many lost heart. Scoffers, too, were numerous, but some enterprising men remained and by their aid examples were provided which added much to our own demonstrations. Dead hoppers, small and hard to find among the grass, were pointed out and as their numbers increased, and the dark areas grew no larger, farmers took heart again; but only temporarily, soon fresh hordes were making their way over the bodies of their dead companions and commenced to eat new inroads into the crop. It was at this time that the human barometer fell very low indeed and but for the former experience of a few men we might have had difficulty in keeping the work going. Some farmers did indeed lose all hope and, later, their crops also. Others of more persistent character continued in their efforts and ultimately had the satisfaction of at least saving part of their crops. As for the dead locusts it is hard to realize the vast numbers that covered the ground. In one instance we found an average of 244 dead to the foot over a large field, that is to say approximately 260 bushels per acre. On one square foot at another place I counted 641 dead locusts, two-thirds of which were adults. I give these instances from many similar ones. Had these locusts been permitted to breed they would have produced at least 6,000 eggs to every square foot of land on the field and these in their turn would have provided locusts enough to destroy fully two thousand acres of crop next year.

Much of the success obtained was due to the Provincial departments supplying the poison free, while the municipalities, as a rule, provided the bran and attractants. There was some delay, however, before these measures were adopted; many farmers in the meantime, procuring their own materials.

Our measures of control did not differ to any marked extent from those in use elsewhere: we relied chiefly upon the Kansas bait partly because it was more easily mixed and also because it seemed more attractive to the grasshoppers than

the Criddle mixture. Another point in favor of the former was the difficulty in securing horse droppings in sufficient quantity. However, there were some farmers in nearly every district who spoke very highly of the droppings and used nothing else. Two instances came to my notice where the farmers had used manure spreaders and while this might seem a rather extravagant method of spreading poison, we must take into consideration the cheapness of the material which would permit a far greater quantity to be used in comparison with Kansas bait, at the same cost. The results of this method were, at least, all that could be desired and probably exceeded any other.

Later in the season a large type of hopper catcher was used, this being an improved model of the old hopper-dozer. It was sixteen feet long and some three feet in height, made, apart from the frame, with galvanized iron. With this implement, drawn by two horses, some farmers claimed to have caught as many as fourteen bushels of locusts in one day. Certainly some excellent work was done with them while the enthusiasm lasted, but in spite of the apparent success I am of the opinion that the machines are a poor substitute for poison baits.

There is one feature in the present locust outbreak that makes it different from any other we have experienced in western Canada and that is the fact that we have had to deal with an entirely different kind of locust. Our previous knowledge referred entirely to the genus *Melanoplus* and chiefly to the Migratory and Lesser Migratory species, whereas the present insects involved are largely the Pellucid locust. It was, perhaps fortunate that we visited the infested districts before giving advice and more so that we were able to distinguish the species involved, because the habits of the two genera are different in many respects. For instance the species of *Melanoplus* we have been dealing with, oviposit in and around small openings amid sparse vegetation, or more frequently still, in the stubble fields. Camnula, on the other hand, avoids such places and instead, selects the roadsides and sodded areas, depositing its eggs in the clumps of grass. It thus happened that instead of swarming of the stubble fields, as might have been expected before knowing the species, the insects came from the roadsides. This was how conditions were in most districts, but in a few *Melanoplus* predominated, while in others, all kinds were found together.

It is an interesting sight to see the small hoppers all moving in one direction, as if all were induced by a similar impulse. These movements may be towards the sun or away from it, with or against the wind so that it is difficult to arrive at a reason for the uniformity of movement. One thing is certain: having once located a field they seldom abandon it while food remains available. Moving inward they first steadily work their way towards the centre of the field while the rear guard clean up what is left, or that which re-sprouts. Large masses of these hoppers may also be seen in the morning while the dew is still on the herbage, sunning themselves before partaking of the morning meal. It is then that they sometimes gather along roadsides so thickly that the road looks black with them: on other occasions they have been known to collect on the railway irons in such numbers as to actually stop the trains. The greatest sight of all, however, is to see a migration after the insects have attained the winged stage. At such times they move in regular swarms and drift along with the wind like a thick snow storm. Such a swarm may last for hours or but a few minutes. All depends upon the weather, when the sun comes out bright and hot the insects are on the wing in a moment, should a cloud obscure that orb's surface, the locusts as quickly drop to earth again. The flights, too, seem to be infectious because no sooner do the

insects from a distance drift past than those in the vicinity fly up to join them and so add to the moving swarm. To witness such a sight for the first time cannot but prove a joy to the naturalist, but it has a very different effect upon the farmer, who perhaps sees the hard work of months brought to nothing in a few hours. We had instances, at such times, when hundred acre fields of wheat where destroyed in two days by successive swarms of migrating locusts. Other fields, however, were actually freed through the insects moving elsewhere. It was owing to these habits that some farmers who had done little still harvested some crop while other men, working hard to prevent the locusts depredations, lost everything.

The almost daily flights mentioned above, naturally scattered the insects far afield and over much new territory, but while they thus moved in vast numbers their movements were much closer to the ground than are those of the Lesser Migratory locust which often rises far above the area of ordinary vision. *Melanoplus* also takes part in the low flights though less frequently. All species commence to migrate soon after they obtain wings, and continue, on and off, for fully a month and a half. In 1919 they commenced to fly about the middle of July and continued for a considerable time after the insects had begun to oviposit. Indeed there is strong evidence to show that the female frequently deposited one lot of eggs and then moved to other territory to complete her work.

During the wingless stages, and for a time afterwards, the Pellucid locust spreads all through the fields and in this habit resembles the common species of *Melanoplus*, but as the breeding season draws near it returns to the sod land, while the latter remain on the stubble to deposit their eggs. This habit alone usually enables us to distinguish the species involved without seeing it. For instance, should a farmer report extensive cutting of twine we are reasonably safe in referring the injury to species of *Melanoplus* because *Camnula* will be on the sod at the time the grain is cut. The only other insect, therefore, that could be involved would be the larger crickets (*Gryllus assimilis*). Another difference is in the kind of soil preferred, the Lesser Migratory locust inhabits sandy land, *Camnula* the richer soil; though both prefer the dry uplands for egg-laying.

The conditions favoring the increase of any particular species are almost sure to be beneficial to the development of others, consequently there are always others present of lesser importance, and in 1919 we had *Melanoplus minor*, which is the earliest to develop; *M. packardii, gladstoni, dawsoni, bivittatus*, and *femur-rubrum*. The first three are upland species while the last two prefer slightly moister situations. I found a remarkable little outbreak of *M. gladstoni* near Pilot Mound which is, I believe, the first occasion that this species has been recorded as notably injurious.

As I have already mentioned, the eggs of *Camnula* are deposited along roadsides or in pasture fields. Contrary to the general idea the insects, with us, prefer the higher land rather than low spots. Any sodded soil is suitable provided it is comparatively dry. In preparing to oviposit the female selects a low clump of grass in which she forces her abdomen to that the egg mass, that she deposits, is situated among the grasses roots. The eggs, however, are always close to the surface and when the grass clump is a dense one, may actually protrude above ground though, of course, hidden amid the base of the plant. Owing to the peculiarity in selecting egg sites the egg pods, too, are frequently massed together and often actually touching one another in their density. In this connection I have found as many as 84 egg sacks within a square foot, that is to say approximately 2,000 eggs.

It was unfortunate that the seriousness of the 1919 outbreak prevented the few of us engaged in control measures from conducting investigations as to the effectiveness of the various poisons or attractants. When it is considered, however, that the Dominion had but one man in each province and that there was work enough for a dozen, it will be readily understood why we were obliged to devote all our time to the immediate needs of the farmers. In other words, we became, for the time being, demonstrators and encouragers rather than research men. When we view the results, however, we cannot but feel gratified at the thousands of acres that were saved even though much was lost also. We have surely demonstrated what can be done with more effective preparation, and as a result organization is well under way to combat the probable outbreak of next year. We know where the eggs are, having made a careful survey during the autumn months and this knowledge will help us much in locating the young hoppers as soon as they hatch out. We can then attack them immediately rather than wait until they invade the crop.

Deep ploughing has undoubtedly accounted for many eggs, especially in those districts where *Melanoplus* predominated. Unfortunately the sod land is much more difficult to attend to and I fear that it will, in most instances, remain untouched. Experiments conducted at the Treesbank Laboratory, have shown that the eggs, even when incased in their usual covering, cannot withstand a temperature of 90°F. for many hours when the sun is shining and, therefore, exposing them early in the season is an effective means of destroying the eggs. A lesser temperature, however, is not as effective though exposing the eggs to the vicissitudes of autumn, winter and spring may help to prevent their hatching.

Turning to the prospects for next year, we cannot, of course, predict with certainty that there will be an outbreak, as weather conditions may intervene, but judging from the past the chances for this are small, in which case we may expect a worse and more widespread outbreak than the one of 1919. As I said before, I think we shall be prepared. This, however, is a matter that the provinces are chiefly taking in hand. Naturally we have all been working together against the common enemy and for myself, I should like to take this opportunity of expressing my appreciation of the splendid co-operation that has taken place. We have been in the field together and worked together for the common benefit.

LIFE-HISTORY NOTES ON SOME SPECIES OF ACRIDIDAE (*ORTHOPTERA*) FOUND IN BRITISH COLUMBIA.

E. R. Buckell, B.A., Entomological Laboratory, Vernon, B.C.

In presenting some notes on some species of Acrididae occurring in British Columbia I do so with some hesitation for the reason that I have not been able to complete the life-history of many of the species. My hope, however, is that such notes as I have prepared will prove of service to those undertaking any further ecological and life history studies on western species of Acrididae.

My thanks are particularly due to Mr. R. C. Treherne for his encouragement and advice during the past two years in this work, and to Messrs. L. P. Rockwood of the U. S. Federal Entomological Station, Forest Grove, Oregon; and Norman Criddle of the Dominion Entomological Branch, for their kindness in assisting me in the identification of species.

The following species represent the majority of the various Acrididae I have collected in British Columbia during the past two years, and the localities where they were taken.

Acrydiinæ (Tettiginæ)

Acrydium granulatum Kirby. Penticton.
Acrydium ornatum Say. Fairview.

Acridinæ (Tryxalinæ)

Pseudopomala brachyptera (Scudder). Vaseaux Lake. Fairview.
Akentetus unicolor (McNeill). Fairview. Westbank.
Orphulella pelidna (Burm). Fairview.
Chlocaltis conspersa Harris. Salmon Arm.
Chlocaltis abdominalis Thomas. Salmon Arm. Vernon.
Stirapleura decussata (Scudder). Naramata. Penticton. Fairview. Vaseaux Lake. O. K. Falls. Keremeos.
Agencotettix scudderi (Burner). Westbank. Fairview.
Aulocara elliotti (Thomas). Westbank. Fairview.
Chorthippus curtipennis (Harris). Penticton. Vernon.

Oedipodinæ

Arphia pseudonietana (Thomas). Salmon Arm. Vernon. Penticton. Fairview.
Camnula pellucida (Scudder). Celesta. Salmon Arm. Vernon. Westbank. Penticton. Fairview. Bridesville.
Hippiscus neglectus (Thomas). Westbank. Penticton. Keremeos. Fairview.
Hippiscus obscurus (Scudder). Westbank. Penticton. Keremeos. Fairview.
Hippiscus vitellinus (Saussure). Penticton. Fairview.
Hippiscus latefasciatus Scudder. Fairview.
Dissosteira carolina (Linnæus). Salmon Arm. Vernon. Penticton. Fairview.
Spharagemon æquale (Say). Vernon. Westbank. Penticton. Fairview.
Mestobregma sp. (probably *kiowa*). Okanagan Landing.
Mestobregma sp. Westbank. Fairview.
Conozoa wallula (Scudder). Vernon. Westbank. Penticton. Fairview.
Circotettix suffusus (Scudder). Celesta. Salmon Arm. Vernon. Westbank. Penticton. Fairview.
Circotettix lobatus Saussure. Fairview.
Trimerotropis cæruleipes (Scudder). Celesta. Salmon Arm. Vernon. Penticton. Fairview.
Trimerotropis vinculata (Scudder). Salmon Arm. Penticton. Fairview.

Locustinæ (Acridiinæ)

Melanoplus atlanis (Riley). Celesta. Salmon Arm. Vernon. Westbank. Penticton. Fairview.
Melanoplus femur-rubrum (DeGeer). Celesta. Salmon Arm. Vernon. Westbank. Penticton. Fairview.
Melanoplus packardii (Scudder). Fairview.
Melanoplus bivittatus (Say). Salmon Arm. Vernon. Penticton. Fairview.
Melanoplus cinereus (Scudder). Fairview.

Acrydiinae.

Two species of the sub-family Acrydiinae were taken during the summer of 1919. Both belong to the Genus *Acrydium*.

Acrydium granulatum Kirby. Large numbers of adults of these insects were taken on April 12th in the meadows at Penticton. During April and May they were common everywhere in damp meadows around Penticton. A few were again taken during the latter part of August. No records of their breeding habits were obtained. The specimens varied greatly in coloration and markings, and all examined were macropterous.

Acrydium ornatum Say. A single male adult of this species was taken on August 7th at Fairview.

Acridinae.

In this sub-family nine species were collected belonging to eight genera.

Pseudopomala brachyptera (Scudder). Two immature insects of this species were taken at Vaseaux Lake, between Penticton and Fairview, on June 14th. No mature specimens were taken this summer.

Akentetus unicolor (McNeill). On June 27th, at Fairview, adults of this species were first seen, and at this date considerable numbers were present on the dry bunch-grass ranges. The nymphs had been observed since the middle of May. By the end of July all were adult and they were found scattered about all over the dry ranges south of Fairview, to the U.S. Boundary Line. A few adults could still be found at the end of August. No observations were obtained as to their breeding habits. These grasshoppers are very active and can jump long distances.

Orphulella pelidna (Burin). These grasshoppers were first taken near Fairview on August 7th (1919) and were found during August fairly commonly near the edges of ponds, and along the banks of the Okanagan River. They were only seen where the grass was still green and were never observed out on the dry ranges. They vary very much in colour, from a dark brown to a bright apple green. They are strong jumpers but do not use their wings much. This is the first time that this insect has been recorded from British Columbia.

Chloealtis abdominalis (Thomas). This species was found in bushy pasture land among dry grass tufts and in burnt-off bush land at Salmon Arm on September 29th. The males were heard stridulating and by approaching them carefully a few were secured.

Only one female was found; it was brachypterous and considerably larger than the males, it was very sluggish and made no attempt to escape but its coloration made it very hard to see among the grass tufts. When the males were at last spotted after a careful stalk they were by no means easy to capture, as they would take one or two big jumps and then burrow down among the leaves and rubbish on the ground, their colour harmonizing closely with their surroundings. When stridulating the males usually crawled up on to a log or stone. These grasshoppers were found again at Vernon on October 4th, on light bush land. The males were stridulating and one or two were secured but I could not find any females. The eggs of this species are laid in rotten logs, fence-posts, etc.

Chloealtis conspersa Harris. One male of this species was taken on September 29th at Salmon Arm while collecting *Chloealtis abdominalis*. These two species are very similar, but *C. conspersa* can be distinguished by having the entire sides of the pronotum and first few segments of the abdomen black, and the lower surface of the last few abdominal segments orange-red.

Stirapleura decussata (Scudder). This species was first observed at Penticton on April 26th on a sheltered stony tract of land from which the snow had gone off early. They were present in considerable numbers but were not very active at this date, not having been out of hibernation very long. A few of them were still in the nymph stage but by far the greater number were adult. As the spring had only opened a short while before and snow was still present on the higher hills, it would have been quite impossible for these to have hatched from eggs this spring and to have grown to adult in this short time. They must, therefore, have hibernated as adults and large nymphs. On May 4th this species was found commonly scattered over the dry range country in the neighborhood of Fairview in the Lower Okanagan Valley. They were most plentiful on stony ground and sage-brush land.

although some were seen on the open bunch-grass plains. They were now fully active and the males could be heard stridulating while at rest upon the ground. When disturbed they would hop away but would not readily take wing. They are silent when in flight. On May 19th this species was found to be egg-laying and from the middle of May to the middle of June oviposition was at its height. From this date on, however, they decreased rapidly in numbers and by the end of June no specimens could be found. I do not know when these eggs hatch, and all that I am able to say about their further life history is that up to September 1st, when my observations ended, no specimens of this species were taken. I think, however, that they would soon have appeared as adults again as another species (*Hippiscus neglectus*) with a similar life history was just appearing again on August 28th.

Ageneotettix scudderi (Bruner). This species was first taken on July 20th at Westbank, and on July 23rd they were found to be fairly common on the dry range land around Fairview. They were very similar in habits and distribution to *Aulocara elliotti* and seemed to take their place, for as *Aulocara elliotti* decreased *Ageneotettix scudderi* increased. Both these species when at their height were the most abundant grasshoppers present on the ranges. Although a small species they were easily seen on the ground on account of their white antennae and bright red hind tibiae. They are an active species with great jumping powers. Toward the end of August they began to decrease and were not so frequently taken, and I think that they had deposited their eggs by this time.

Aulocara elliotti (Thomas). This species at the end of June was the most plentiful grasshopper on the dry range country of the Southern Okanagan Valley. I do not know when this species first appears as adults but I should judge that it would be during the second week in June. By the middle of July adults were very plentiful and were evenly distributed over the range country south of Penticton. It was seen egg-laying in the third week in July from which date it decreased in numbers, its place being taken by a very similar but smaller grasshopper *Ageneotettix scudderi*. *Aulocara elliotti* is a powerful jumper but does not make much use of its wings. A few adults could still be found up to the end of August. The females are very much larger than the males and varied considerably in coloration, some having the white markings on the pronotum very distinct, while in others these markings were hardly visible. The males appeared to be far more numerous than the females and were very active, running on the ground with considerable speed. On several occasions from three to five males were observed following a female. In each case the female was hopping while the males were running rapidly behind.

Chorthippus curtipennis (Harris). Adults of these grasshoppers were collected in considerable numbers on September 1st in a damp meadow at Penticton where the grass was long and green. The males could be heard stridulating. I do not know when this species first appears as adult.

Oedipodinae.

In the Oedipodinae fifteen species were collected belonging to ten genera.

Arphia pseudonietana (Thomas). The first adults of these grasshoppers were seen on July 18th at Penticton. It has practically the same distribution in the Okanagan Valley as *Dissosteira carolina* and appears at about the same date. It is rather more common and more evenly distributed over all types of land than is *D. carolina*, which remains together in small flocks on certain dry hill sides, railroad tracks, etc. The disk of the wing in *A. pseudonietana* is dark red. The

general body colours do not vary much. The usual colour is dark blackish brown with black speckles; the female being larger and lighter in colour. Some specimens are found with a chalky-white pronotum and two or three white bands across the top of the hind femora. This grasshopper flies with a rather slow zigzag flight and can produce, at will, a slow rattling noise when on the wing. Egg-laying is commenced in the last week in August.

Camnula pellucida (Scudder). This species is probably the most destructive grasshopper that we have in British Columbia and has at various times caused very great loss to stockmen and farmers by increasing in enormous numbers and completely destroying crops and range grasses. This year it has been singularly scarce in the Okanagan Valley although it was plentiful in northern Washington State, crossing the British Columbia Boundary Line into the Bridesville-Rockcreek section where it did considerable damage. The first adults were seen at Fairview on June 12th when small swarms were observed in damp places near the Okanagan River where the vegetation was still green. Mating took place during the middle of August and eggs were being laid during the last week in August and doubtless continued until killing frosts occured in the fall.

Hippiscus neglectus (Thomas). The first specimen of this species was found at Penticton on April 4th when the ground was still frozen in many places, and snow was still present in the bush. This specimen was a nymph and was nearly full grown. On April 26th they were found commonly at Penticton and nearly all were adult. On May 4th at Fairview adults were plentiful. These grasshoppers were found in company with *Stirapleura decussata* and *Hippiscus obscurus* and in similar locations, i.e. stony flats and sage-brush lands and a few were seen out on the open bunch-grass plains of the Okanagan Valley. They are not very active and were never observed to stridulate. On May 19th females were seen with their bodies distended with eggs, and they were observed ovipositing in late June. These grasshoppers vary much in coloration and size and are similar to *H. obscurus* differing from this species by the presence of a distinct tegminal stripe. There are two colour varieties, the first having the disk of the wing red and the hind tibiae yellow, and the other the disk of the wing yellow and the hind tibiae red. From my observations this year it appears that the first variety, with red wings, appears first, preceding the yellow-winged variety by several weeks and is also the first to disappear, and this peculiarity seems to be the case with *H. obscurus* also. Adults resulting from the eggs laid in late May and June were beginning to appear during the last week in August and possibly some eggs may be laid in the Fall but the majority of the adults and nymphs seen in the Fall evidently hibernate and reappear in the spring.

Hippiscus obscurus (Scudder). These grasshoppers appear to have exactly the same life history as *Hippiscus neglectus* and only differ from them in the absence of the tegminal stripe. They have the two colour varieties, with the red wings and yellow hind tibiae, which, as before, are the first to appear; and those with yellow wings and red hind tibiae, which are later in appearing. They were found with *Hippiscus neglectus* and *Stirapleura decussata* at Penticton and Fairview in the spring, and freshly emerged specimens were seen again during the last week in August. I believe that this grasshopper is, by some writers, considered to be a variety of *H. neglectus* and not a distinct species.

Hippiscus vitellinus (Saussure). This grasshopper is very similar to *Hippiscus obscurus* but differs from it by having regularly distributed blotches

on the tegmina instead of dark areas tending to form bands. A few were taken at Penticton and Fairview while collecting *H. neglectus* and *H. obscurus*.

Hippiscus latefasciatus (Scudder). Only two adults of this species were seen and both were females. The first was taken on May 4th and the second on May 18th at Fairview. The body of the female taken on May 18th was distended with eggs. Consequently I think that this is another species which hibernates, lays its eggs during May and June, and then reappears in September and October, but further observations are required to determine this. The only other locality where this species has been recorded in British Columbia to my knowledge is from Lillooet, where it was taken by Mr. R. C. Treherne.

Dissosteira carolina (Linnæus). This grasshopper is common along road sides and hard dry places throughout the Okanagan Valley. The first adults were seen at Westbank on July 20th and by the middle of August these grasshoppers were common everywhere. They are very variable in size and colour; some males can be found which measure very little more than an inch in length, while some females measure more than two inches. The general body colour ranges from a pale straw to nearly black passing through various shades of rusty-red and brown. This species is a great lover of dusty roads and may be found in the centre of large towns. By the end of August they were egg-laying. Several were seen in Penticton ovipositing in the earth between the boards of the side-walks. The males of this species have a rather curious "song" during mating time; they jump up into the air until about three feet from the ground and there remain hovering like a hawk in the same spot their wings making a soft rustling sound. After remaining in this position for about half a minute they flutter down to the ground again. There is no dancing up and down and no clicking sounds produced as in the genus *Trimerotropis* or *Circotettix*. This species is found until killed by the frost.

Spharagemon aequale (Say). Adults of this species were seen first at Westbank on July 20th where they were present on the dry range land in considerable numbers. They are active insects often flying long distances before alighting again. When disturbed they fly away in a straight line keeping close to the ground and turning suddenly to one side immediately before alighting, run along the ground for several feet before remaining quiet. This species was frequently seen attacked by a Sarcophagid fly while in flight. During August they were common everywhere on the range lands of the Okanagan Valley and were usually associated with *Trimerotropis vinculata* which they closely resemble. They were seen ovipositing during the latter part of August. A few adults could still be found on the ranges at Vernon on September 15th. The adults of this species were never found together in large numbers but were evenly distributed all over the bunch-grass benches in the valleys and also on some of the higher ranges. There was one very marked variety of this species which was fairly often seen in which the light and dark bands on the tegmina were very clearly defined and the posterior half of the pronotum was white, causing the insect to show up quite conspicuously when resting upon the ground.

Mestobregma (probably *kiowa*). A large number of these grasshoppers were seen on a dry gravelly piece of land adjoining the shore at the north end of the Okanagan Lake, at Okanagan Landing, on September 8th, 1918. I have not taken this species since and they could not be found this year (1919) on the gravelly patch at Okanagan Landing where they were common last year although I searched for them on the same date.

Mestobregma sp. This is an extremely pretty grasshopper when alive; pinned specimens soon lose their colours. Adults of this species were first taken at Fairview on June 27th. During July a few were seen at Westbank and an occasional adult was taken in the neighborhood of Fairview up until the end of August. This species was never found in any numbers, but one or two might be found in a day. They were taken out on the dry bunch-grass flats and were very inactive, often allowing themselves to be caught by hand. No notes were obtained as to their egg-laying habits nor were they ever observed to produce any sound.

Conozoa wallula (Scudder). This was a very common species in certain localities and on certain types of soil. Adults were first observed in large numbers at Westbank on July 20th on a piece of flat sandy ground running out into the Okanagan Lake. This species was seen in many places in the Okanagan Valley, but when observed was always on dry, hot, sandy spots, such as roadsides, waggon tracks across the ranges, on pieces of sandy land in the bend of rivers, or along lake shores. Where they occurred they were usually in large numbers. Although they were all adult by the end of July I noticed no decrease in their numbers at the end of August and I think that they would probably be present until killed by frost. They were very inconspicuous on the ground and very difficult to catch as they were very quick in leaving the ground. When disturbed they only flew a short way before alighting again. The sexes were pairing during the middle of August. This species seemed to be particularly infested by the red mite *Trombidium locustarum,* and I saw some specimens whose under wings were so covered by these mites that they were unable to fly or even to close their tegmina. There were usually some Tachinids and Sarcophagids flying about among these swarms of grasshoppers. The Sarcophagids were observed to dart at the grasshoppers, while they were in flight, as if to place an egg or living larva upon the bodies of the grasshoppers before they closed their wings on alighting. This same thing was noticed in the case of *Spharagemon aequale* and *Trimerotropis vinculata.*

Circotettix suffusus (Scudder). Adults of this species were first collected at Westbank on July 20th where they were commonly seen along the roads. I do not know when this species first appears but I do not think that those collected on this date had been in the adult state long. I did not see many of these grasshoppers this summer in the Southern Okanagan Valley. This is one of the dominant species at Salmon Arm during August and September and may be found commonly in the orchards and along the roads. On September 29th I found large numbers of them in the orchards in company with *Trimerotropis caeruleipes.* They were depositing eggs in the hard ground around the apple trees and nearly all were in good condition, so that in this locality at any rate, they are one of the chief species present during September. This grasshopper is a strong flier and hard to capture. When approached they leave the ground very rapidly, rising to five or six feet in the air and then zigzag away making a very loud and sharp clicking noise.

Circotettix lobatus (Saussure). These grasshoppers were only taken in one or two localities. They were found in considerable numbers on August 7th near Fairview on a rock slide at the foot of a cliff. The males produce a loud crackling and snapping sound when on the wing. They have a regular "song" at mating time; dancing up and down in the air, producing five or six sharp clicks followed by a shrill rattling sound, very similar to the noise made by a rattle-snake. As these grasshoppers seem to occur almost entirely on rocky slopes at the base of cliffs, which is a favorite haunt of the rattle-snake, I have often found that people

mistake their "song" for a rattle-snake which is common in that locality. This species often flies high up on the rocks and rests on the perpendicular face of the cliff and is very hard to capture, its colours harmonizing with the green and grey of the rocks. I do not know where they deposit their eggs.

Trimerotropis caeruleipes (Scudder). This grasshopper does not seem to be at all common in the Okanagan Valley, more especially in the southern half, but is one of the commonest species at Salmon Arm and at more northerly points. It was first taken in the adult form on July 20th at Westbank and a few were collected at Fairview and Penticton during the latter part of August. The only place where this species was seen in any numbers was at Salmon Arm on September 28th. On this date is was seen in large numbers in the orchards and appeared to be at its maximum abundance. They were observed to be pairing and a few were egg-laying. They were found in company with *Trimerotropis vinculata, Circotettix suffusus,* and *Arphia pseudonietana.* The males of this species are much smaller than the females and produce a soft clicking sound when in flight. Frosts of thirteen and ten degrees on September 27th and 28th respectively, caused no visible decrease in the numbers of this species.

Trimerotropis vinculata (Scudder). Adults were first taken at Westbank on July 20th, and from that date on were found in company with *Spharagemon aequale* all over the ranges at Fairview. A few adults were taken at Salmon Arm on September 29th, and had, I think, completed their egg-laying.

Locustinae.

Five species of Locustinae were collected. All belong to the genus *Melanoplus.*

Melanoplus atlanis (Riley). This year there have been remarkably few of any of the genus *Melanoplus* present in British Columbia in the localities where they are usually common. In the southern Okanagan Valley there were very few grasshoppers of this species present. The only place in B.C. to my knowledge, where this species was common was at Celesta on the Shuswap Lake where an outbreak of considerable severity occured. Both this species and *Melanoplus femur-rubrum* have been far more plentiful this year in the humid sections of the Province than they have in the Dry Belt where they are usually most in evidence. They began to hatch about the middle of June, the first of them becoming adult in the latter part of July. Nymphs of this species were still to be found in the beginning of September. Eggs were being deposited during September.

Melanoplus femur-rubrum (DeGeer). These grasshoppers have been fairly numerous this year throughout the Province and I have seen more of this species than I have of *Melanoplus atlanis* which is usually the more abundant species of the two in British Columbia. This grasshopper began hatching about the middle of June and the first adults were taken on July 20th at Westbank. The hatching period of these grasshoppers seems to be very protracted, for nymphs were still found on September 21st in considerable numbers at Vernon. This species was responsible for the outbreak in the Lower Fraser Valley this year. Eggs were being laid during the first week in September and doubtless continued until the frost killed the adults.

Melanoplus packardii (Scudder). This species was only taken on one or two occasions in the Okanagan Valley close to Fairview. It was first seen in a dry gully on June 27th, on which date only a few were adult. On August 22nd this gully was again visited and a considerable number of specimens caught and all were adult. Oviposition began in the third week in August. An odd specimen

was found here and there on the open ranges but it was nowhere very plentiful and not more than fifty specimens were seen during the entire summer. The specimens collected belonged to the form *rufipes* (Cockerell).

Melanoplus bivittatus (Say). This grasshopper was not seen very often this year and did not seem to be nearly as common as usual. The first adult taken was at Fairview on June 27th, but from this date until the middle of August no adults were seen. During the last week in August and in the first week in September a considerable number of females were taken while depositing eggs in the earth betwen the planks of the side-walks at Penticton. At the end of September ragged adults could still be found at Vernon and some eggs were still being deposited.

Melanoplus cinereus (Scudder). Adults of this species were first collected at Fairview on August 7th, and were found during August very occasionally in this locality. They are very pale in colour and have bright blue hind tibiae when alive. Only one male of this species was taken and ten females. They were all taken among sage-brush and *Chrysothamnus* bushes. When disturbed they jumped for great distances and using their wings would usually land in one of these bushes, thus making it very difficult to capture them. Several were found by shaking the *Chrysothamnus* bushes in which they seemed to spend a good deal of their time. They were observed to feed on the leaves of the *Chrysothamnus*. Several large nymphs of this species were seen on August 23rd. This is the first record of this species from Canada.

ONE YEAR'S EXPERIMENTS IN THE CONTROL OF THE CABBAGE MAGGOT.

W. H. Brittain, Provincial Entomologist for Nova Scotia.

Experiments in the control of the cabbage maggot (*Phorbia brassicae* Bouche) were initiated in a small way at Truro in 1917, as a joint project to be carried on co-operatively by the Horticultural and Entomological Departments of the Agricultural College. In 1918 these experiments were continued on a larger scale and the 1919 experiments have grown out of the work of the previous two years, of which they are simply the continuation. Since the records for 1919 reveal nothing inconsistent with the results of the previous seasons, it has been considered sufficient, for the purpose of this paper, to confine our attention entirely to the former. None of the results herein outlined should be considered as final, but we believe that they indicate promising lines for further research, and they form the basis for another season's work. While the utmost care was taken to make the records as accurate as possible and to eliminate possible sources of error, our findings will all be checked up in subsequent seasons before definite recommendations based on our own experiments can be made.

Control Investigations, 1919.

The plots in which the different control experiments were conducted in 1919 were divided into three main series. The first series designated "continuation plots," included trials of those materials found to be of promise in previous years, either in our own experiments or in those of other workers. The second series which were called "field plots," included the three treatments which previous results showed to be most promising, these being applied to later cabbage on a

field scale. The last series known as "trial plots" includes methods or material not previously tested by us.

In addition to these there were a number of small miscellaneous experiments conducted with a view to determining the exact method of action of some of the chief materials used.

I. Continuation Plots.

These plots were situated on a piece of ground 275 ft. long by 30 ft. wide. The plants were set out in rows 2 ft. apart and 18 inches apart in the rows, there being 12 rows each containing 240 cabbages of the Early Jersey Wakefield variety. With the exception of tar paper discs and wire screens, 2 applications of each treatment were made, the first on May 21st, the day the adult flies first made their appearance, and again on May 31st.

The different plots were arranged in triplicate and each section removed as far as possible from the corresponding one, to make more certain of securing a uniform infestation. The table lists the different treatments and gives the results obtained from each. The figures given are representative of costs at Truro during the past season and would doubtless vary materially in different localities and in different seasons. Since, however, they indicate the actual set of conditions encountered by us in growing the crop and treating it for the maggot, they are here given. The figure showing cost of production of an acre of cabbage was worked out and furnished us by Mr. James Dickson of the Horticultural Department of the College.

In the following table showing the results of the different treatments the weight of the heads is taken as the main basis for comparison for several reasons, the most important being that, under our conditions of marketing, sales are made by weight. Consequently, it is simplest to make our calculations on that basis. More important is the fact that this is the only really *quantitative* way to record results. Simply to give the number or percentage destroyed is insufficient, since many cabbages may be dwarfed or retarded, though not actually destroyed or rendered unmarketable. It would be impossible to record the number dwarfed as a result of the work of the maggot or to indicate in any way the degree of dwarfing, since there is no method of determining from the appearance of the plants just where it begins or ends. On the other hand, the total weight from each plot indicates this in a very exact manner. It also brings out the fact that certain treatments increase the weight of heads produced, irrespective of their insecticidal value. The weight, therefore, is the best method of expressing results of the different treatments. The actual price obtained for the cabbage from each plot has been recorded, since this is the point that most interests the commercial grower and is the ultimate test of the practicability of any treatment. The average price per pound is also an important item, for certain treatments retard and others accelerate the developments of the head. Those that hasten the heading up process result in a higher price per pound, as the earliest cabbage brings the highest price.

It will be seen that the tar paper discs from which the earth was removed after the first two cultivations, gave the only absolutely perfect stand outside of the wire screens. In weight of heads, in price per pound and in total net profit per acre, this plot is greatly inferior to the one receiving corrosive sublimate 1—1,000, though this plot lost a single plant. Curiously enough double the strength of corrosive sublimate did not increase the efficiency of the material, but rather appeared to reduce it. Either directly or indirectly the use of this material seemed to bring about a great increase in the weight of heads produced.

TABLE I.—Cabbage Maggot Control Experiments—Continuation Plots, 1919.

Plot No.	Treatment.	No. Plants destroyed.	Per cent. destroyed.	Weight of Cabbages per plot at harvesting.	Average weight of head.	Calculated No. of lbs. per acre.	Average price per lb.	Price received.	Calculated price per acre.	Cost of Treatment per acre.	Net Profit* per acre.
				lbs. ozs.			c.	$ c.	$ c.	$ c.	$ c.
1	Wire screens	.....	.....	394 8	1.6	22,989.49	4.38	17 30	1,009 17	265 81	568 96
2	Tar paper discs	55	22.9	409 12	2.2	23,878.18	4.39	18 00	1,050 00	42 00	833 60
3	Scotch soot	75	31.25	326 12	2.0	190,413.56	4.37	14 28	833 00	80 90	577 70
4	Check	183	76.25	139 8	2.4	8,041.95	4.69	6 54	381 50	Check	207 10
5	Tobacco dust .. Washing soda .. Filler ..... } equal parts	67	27.9	384 8	2.2	22,406.74	4.26	16 37	957 92	48 80	731 72
6	Tobacco dust .. Soap powder... Filler... ..... } equal parts	53	22.1	378 0	2.0	22,027.95	4.17	15 75	918 75	48 80	695 55
7	Tobacco dust .. Scotch soot .... Soap powder... } equal parts	18	7.5	537 0	2.4	31,293.68	4.22	22 65	1,321 25	63 42	1,083 43
8	Tobacco dust... Sulphur..... } equal parts	60	25	275 4	1.5	16,040.19	5.58	15 29	891 92	58 44	759 08
9	Corrosive sublimate (1-1,000)....	1	0.4	638 12	3.0	37,223.16	4.26	27 17	1,584 92	45 82	1,464 70
10	Corrosive sublimate (2-1,000)....	3	1.25	587 4	2.5	34,221.99	4.17	24 48	1,428 00	73 54	1,180 06
11	Tar paper discs. Kept free of soil	.....	.....	503 8	2.0	29,341.46	4.19	21 01	1,225 58	53 20	997 98
12	Tobacco dust and lime ..... } equal parts	69	28.75	305 8	1.7	17,803.04	3.99	12 19	711 08	39 90	496 78

* Cost of raising plants, setting in field, cultivating, cutting and packing, etc., $174.40.

The foregoing treatments are so greatly superior to any of the others that the latter may be disposed of in a few words. The tobacco dust, soap powder and soot mixture is worthy of note as coming next in efficiency to the foregoing and giving a heavy average weight of head. The tar paper discs from which the soil was not removed, were markedly inferior to those where this was done. The screens, while giving perfect control, are too costly and their application too laborious ever to come into general use, and in addition, they seem to have a bad effect upon the plants. The tobacco dust and lime, while inferior to the foregoing in maggot control gave, nevertheless, greatly superior results to those of last season. This is doubtless due to the fact that the material was put on fresh when the flies first appeared and then renewed ten days later. The previous season the material was applied several days before the appearance of the flies, a heavy rain intervening between that time and their appearance. The tobacco dust is apparently only effective when fresh and its usefulness is destroyed by a heavy rain. In conjunction with sulphur, washing soda or soap powder, is apparently more effective than with lime.

It is interesting to note that practically all the substances used in our continuation plots were mentioned by Slingerland in his bulletin on this insect (Bul. 78, Cornell Univ. Agr. Expt. Sta., 1894), though he did not consider them in all the combinations used by us. Among the effective methods he lists screens and tar paper discs; among the ineffective, soot, sulphur and tobacco dust. The two former he did not test himself, but he did some experiments with the latter, which did not turn out entirely satisfactory. The material was applied twice, the first time immediately after planting, the second ten days later. He does not state whether the flies were out at the time of the first application, but says that they were abundant at the time of the second. As a result of the experiments nearly one-half of the treated plants were salable, while only 90 marketable heads were secured out of 600 of the untreated plants.

Particularly interesting is his mention of corrosive sublimate in view of the success that has lately attended the use of this chemical. On this account we reproduce his remarks in full:

"An editorial in 1864 (*Country Gentleman,* p. 65) states that a contemporary recommends 1 oz. of the substance dissolved in 4 gals. of water. A correspondent of a Canadian Journal (*American Cultivator* for April 30, 1881) says all of the London market gardeners secretly use a solution of ¼ oz. of this substance in 4 gals. of water for these maggots. He has used the solution quite extensively, using enough to saturate the ground. But it is not clear from the account whether it is applied as a preventive or whether it kills the maggots. We have little faith in its effectiveness but it should be further tested."

The foregoing shows that this material was in use many years ago and it seems strange that it never seems to have made headway until recently. The reason for this may have been that the average person takes no notice of the infestation until the plants begin to wilt, when the maggots are well grown and it is too late to apply control measures. All our experiments indicate that to control the maggot a material must be either a repellent, in which case it should be applied at planting or before the flies appear or, it should be one that will destroy the eggs of very young larvæ, a fact that has often been lost sight of in studies of this pest. If the cabbage can be protected for even two weeks after setting out, our experiments indicate that it stands a very good chance of surviving the attacks of the maggot.

II. Field Plots.

Field tests were conducted on 3,200 cabbages (Danish Round-head). These were the treatments showing most promise in the previous years' experiments. The plants were set out on July 19th during the emergence of the 2nd brood flies and while oviposition was actively proceeding. There was some infestation of the plants in the seed bed, which was mostly, but probably not entirely, removed by carefully washing the roots in water. Two applications at intervals of one week were made in the case of corrosive sublimate. One application of the dust was made and the earth was not removed from the discs after cultivation.

Field Teste on Late Cabbages (3,200 Plants).

Plot No.	Materials used.	No. of Plants.	No. destroyed by maggot.	No. with marketable heads.	Per cent. destroyed by maggot.	Per cent. with marketable heads.
1	Tar paper discs	800	42	758	5.25	94.75
2	Tobacco dust, soap powder and soot (equal parts.)	800	104	696	13.0	87.0
3	Corrosive sublimate (1–1,000.)	800	11	789	1.375	98.625
Check		800	350	450	43.75	56.25

Field Tests on Late Cauliflower (280 Plants).

Plot No.	Materials used.	No. of Plants.	No. destroyed by maggot	No. with marketable heads.	Per cent. destroyed by maggot.	Per cent. with marketable heads.
1	Tar paper discs	70	5	65	7.14	92.86
2	Tobacco dust and sulphur (equal parts.)	70	15	55	21.42	78.58
3	Corrosive sublimate (1–1,000.)	70	4	66	5.71	94.29
Check		70	16	54	22.86	77.14

The accompanying table shows the treatments given and the results. It will be seen that the corrosive sublimate is again superior to the other treatments, the control being almost perfect. While the other two treatments were hardly given a fair chance in comparison with the corrosive sublimate, the lesser cost of the latter and the prospect of still greater reduction in the price of the material, places it definitely ahead as a method of control of the cabbage maggot.

A similar experiment was carried out on a small adjoining block of cauliflowers, using sulphur in conjunction with the tobacco dust, instead of Scotch soot and soap powder. The results, as will be seen from the table, are comparable.

It was originally intended to make further tests using the main crop of late cabbage, but this was not done as our investigations brought to light the fact that July planted cabbage suffer very little from the attacks of the maggot.

CABBAGE MAGGOT CONTROL EXPERIMENTS TRIAL PLOTS, 1919.

Plot No.	Treatment.	No. Plants destroyed.	Per cent. destroyed.	Weight of Cabbages per plot at harvesting.	Average weight of head.	Calculated No. of lbs. per acre.	Average price per lb.	Price received.	Calculated price per acre.	Cost of Treatment per acre.	Net Profit per acre.
				lbs. ozs.			c.	$ c.	$ c.	$ c.	$ c.
A	Once transplanted stock	66	33	363 12	2.3	21 262.5	2.65	8 05	563 53	Check	389 10
B	Double dosage nitrate of soda	66	33	383 8	2.8	26,845	2.94	11 31	791 70	..	617 30
C	Planted from seed *	35	17.5							..	
D	Twice transplanted stock	88	44	344 0	3.0	24,080	4.47	11 96	837 20	..	662 80
1	Creosote, 1% / Clay, 99%	2	1	712 0	3.5	49,840	3.73	26 61	1,862 70	26 08	1,662 22
2	Dry lime sulphur, 20% / Clay, 80%	93	46.5	232 8	2.2	16,275	2.89	6 74	471 80	49 12	248 28
3	Dry lime sulphur, 20% / Tobacco dust, 40% / Clay, 40%	21	10.5	409 12	2.3	28,682.5	3.35	13 75	962 59	78 16	711 94
4	Anthracene oil, 1% / Clay, 99%	3	1.5	574 0	2.9	40,180	3.57	20 50	1,435 00	27 26	1,223 40
5	Tobacco dust, 40% / White arsenic, 5% / Clay, 55%	4	2	550 8	2.8	38,535	3.73	20 55	1,438 50	52 62	1,211 48
6	Dry lime sulphur, 20% / Arsenate of soda, 7% / Clay, 73%	137	68.5	134 12	2.1	9,432.5	3.41	4 60	322 00	77 94	69 66
7	Tobacco dust, 40% / Corrosive sublimate, 1% / Clay, 59%	1	0.5	643 4	3.2	45,027.5	3.74	24 11	1,687 70	78 16	1,425 14
8	Nicotine sulphate, 2% / Clay, 98%	25	12.5	430 8	2.5	30,135	3.05	15 09	1,056 30	53 44	828 46
9	Free nicotine (40% solution), 2% / Sulphur, 98%	51	25.5	499 4	3.4	34,947.5	3.76	18 77	1,313 99	53 30	1,129 40
10	Salt solution (50% saturated)	48	24	416 4	2.7	29,137.5	3.41	14 22	995 40	61 30	760 10
11	White arsenic, 5% / Clay, 95%	68	34	322 4	2-4	22,557.5	2.92	9 44	660 80	33 58	452 82
12	Para-dichlorobenzene, 10% / Clay, 90%	12	6	560 8	3.0	29,235	3.67	20 59	1,441 30	52 56	1,214 90
13	Para-dichlorobenzene, 10% / Scotch soot, 90%	6	3	650 12	3-4	45,552.5	3.86	25 16	1,761 20	105 90	1,480 90

Cost of raising plants, setting in field, cultivating, cutting, packing, etc., $174.40.

* Complete records not available from this plot.

Trial Plots, 1919.

For trial of treatments not previously tested in our experiments, we had at our disposal a section of land 170 ft. wide by 60 ft. long. With the rows of cabbage 2 ft. apart, there was thus space for 85 rows of cabbage, and with the plants 18 inches apart in the rows, 40 plants for each row. With seventeen different treatments including checks, this gave us 200 plants (Copenhagen Market) for each plot. Instead of having all the 200 plants for each plot together, however, we divided the piece into five sections, one row i.e., 40 plants in each section being devoted to each of the different treatments. We thus had on this piece of ground five repeatings of each treatment, this method tending to equalize variations in intensity of maggot infestation and any in equalities of the soil that might affect the final weight of heads from each plot.

It will be seen that there are four check plots, each receiving a different horticultural treatment, but none protected from the maggot. All the other treatments with the exception of the salt solution were in the form of dry powder and were applied at the rate of 700 lbs. per acre. In the case of the salt, a saturated solution was first made and this then diluted with an equal quantity of water.

Three of the sections were planted May 31st, the remaining two, June 2nd. An exception to this were the plants on Check Plot D, which were planted a week earlier than the others. It was intended to plant them all on the same date, but conditions arose which made this impossible. Normal applications of nitrate of soda, i.e., 250 lbs. per acre, applied in two equal sowings on June 11th and June 28th were made. On Check B, an extra application was applied on July 12th, this plot receiving a total amount equal to an application of 500 lbs. per acre. All the treated plots received two applications of the material used, the first at planting, the second on June 13th. The first brood flies were actively ovipositing at the time of planting.

Discussion of Results.

Had it been possible to set out these plots two weeks earlier, it would naturally have been a more severe test of the different materials, since they would have been exposed for a longer period during the height of the oviposition period. At the same time the number lost in the check rows enables us to make sufficiently striking comparisons.

A consideration of the results from the check plots shows that "A" and "B" are equal as regards the number of plants killed, but the acceleration of the heading process and the greater weight of head, owing to the extra application of nitrate, have given us a much larger price per acre in the case of "B." Obviously, the results of this treatment would depend upon the chemical requirements of the soil. Plot "C" shows a lower rate of infestation, due doubtless to the fact that it escaped the period of most active oviposition. It also missed the high prices obtained for the early crop. Check Plot "D" having been planted earlier than the others, cannot, unfortunately, be compared with them on an equal basis. Exposed during a longer period of active oviposition, more plants succumbed than in the other check plot. Had conditions been different it is not likely that this would have occurred. As it is, the greater average weight of the heads which survived and the earlier heading up of the plants, gives us the largest financial returns of any of the check plots.

It is obvious that some of the treatments are entirely inadequate to control the maggot. A few show a decided advantage over the check plots, but not sufficient to make them worthy of further trial, in view of the very much better results obtained by other materials. In this class may be mentioned nicotine sulphate and clay, nicotine and sulphur, para-dichlorobenzene alone, and salt solution in the strength tested. Others actually appear to have weakened the plants to such an extent that a greater number succumbed to the attacks of the maggot than on the check rows. These include dry lime sulphur, white arsenic, arsenate of soda and combinations of these compounds. No further discussion is necessary regarding these two classes, all the required facts being found in the table.

A consideration of the other treatments shows that Plot VII, (the tobacco dust, corrosive sublimate and clay mixture) gave the smallest number of plants actually destroyed, but Plot I (creosote) is a close second with only one more casualty and with the largest tonnage per acre of any plot, lower cost of treatment and greater profit per acre. Plot IV (anthracene oil) is only slightly behind the foregoing in number of marketable heads produced, but it also falls below Plot XIII (para-dichlorobenzene and soot) in tonnage per acre. This is probably due to another reason than maggot control as will be seen later. The treatment given to No. V (tobacco dust, white arsenic and clay) is apparently next in efficiency, but this plot also falls below No. XIII in tonnage per acre, and even No. XII (para-dichlorobenzene and clay) which lost three times as many plants, has produced a greater weight of head. No. XIII actually comes second in tonnage per acre produced, though behind the plots previously mentioned in the number of plants free from injury. The plants in this plot were noticeably benefited by the treatment, having a deeper green colour of leaf and a healthier general appearance than the other plots. The results from the foregoing treatments are considered promising and will be tested further in the "Continuation Plots" of 1920. Tested out on earliest planted cabbage, the relative merits of these materials as compared with the test in the "Continuation Plots" of 1919, should be clearly indicated.

THE CONTROL OF THE CABBAGE ROOT MAGGOT IN BRITISH COLUMBIA.

R. C. Treherne, Entomologist in Charge for British Columbia, and M. H. Ruhmann, Assistant Provincial Entomologist.

At the request of Mr. Arthur Gibson, Chief, Division of Field Crop and Garden Insects of the Dominion Entomological Branch, the virtue of the corrosive sublimate treatment for the control of the Cabbage Root Maggot, *Phorbia brassicæ*, was tested in British Columbia during 1919, in comparison with the Tar-paper-disc method of control. At Mr. Gibson's further request the following report is submitted on the record of the experiments performed.

The Plan of Experiment.

The work was conducted altogether in the large commercial vegetable-growing district of Armstrong, B.C., where the Cabbage Root Maggot has for several years exacted a heavy toll. The "block" system of experimentation was adopted in preference to the "row" system. Twelve blocks were employed, with from

70 to 210 plants to a block. Three control untreated blocks were interspaced between the treated blocks and they, with the tar-paper blocks, only received applications of ordinary water on the same occasions as the treatments of corrosive sublimate were made. Six tar-paper-disc blocks, consisting in all of 611 plants were employed in the experiment, interspaced between the other blocks, and three corrosive sublimate blocks on which various strengths were used, at 1 oz. to 6 gallons, 1 oz. to 8 gallons and 1 oz. to 10 gallons of water. The corrosive sublimate blocks were in turn divided into three parts, which received respectively 1, 2 and 3 applications in the season. Observations were made on cabbages and cauliflowers. The following notes deal with cauliflowers in particular and, inasmuch as the cauliflower is more susceptible to injury than the cabbage, it would necessarily follow that what was shown to be the case with the cauliflower would also be so with the cabbage. Cauliflowers were transplanted on May 3rd and set in their permanent positions in the field, and tar-paper discs were placed around the plants at this time. Applications of corrosive sublimate were made on May 7th, May 13th and May 23rd; the first application requiring the use of 1 gallon of diluted mixture, the second application 1½ gallons and the third nearly 2 gallons per 100 plants. One cultivation was given the entire plantation after transplanting between May 3rd and May 23rd.

In checking results a great deal of care was exercised to determine exactly what caused the plants to die or suffer, and observations were made on the vegetative growth and development of the root system. Every plant received a separate number and each was checked weekly throughout the period of the experiment.

Results of Experiment.

The untreated blocks of cauliflowers showed considerable (76.5 per cent.) characteristic injury from maggots and stood out very clearly in the plantation. The tar-paper-disc blocks showed pronounced injury but only 25.3 per cent. of the injury caused was due to maggot attack. Fully 36 per cent. was caused by a "wilt" produced by the presence of the disc. It would be well to mention clearly at this point, that the field chosen for the experiments was a low-lying one with a large quantity of vegetable matter in the soil composition, with a tendency to remain cold for a long time in the spring months. The sun is usually very warm in the Okanagan Valley during May and this last year was no exception in this regard. Consequently with conditions such as these, on cauliflowers, the influence of heat acting on and in association with the subsoil moisture produced a condensation of moisture beneath the disc below the soil surface. This condition was not observed in the case of the cabbages, for the reason that the growth of a cabbage is sufficiently strong to outgrow many adverse conditions. Any check in the growth of cauliflowers is serious in commercial growing, as a process known as "buttoning" takes place. This "wilt" condition was not observed in any case with the plants treated with corrosive sublimate, but some plants were injured by the proximity of fresh manure to the roots, causing the loss "from other causes" shown in the table given below. In fact after three treatments with corrosive sublimate at all three strengths the loss due to maggot attack was less than 2 per cent., and the growth of the plants in "top" and "root" was double the growth on any other block. The results clearly showed that under "bottom" land conditions, with cauliflowers, tar-paper discs were unsatisfactory and that corrosive sublimate in three treatments at 1 oz. to 8 or 10 gallons gave eminently

satisfactory and safe results. With cabbages growing in the same field under same conditions as the cauliflowers the loss due to maggot attack varied in different parts of a two-acre field from 18 per cent. to 50 per cent. Where cabbages had tar-paper discs applied as was the case in one acre, the loss averaged rather less than 5 per cent. from maggot attack. This loss from maggot attack, when tar-paper discs were used in previous years, is considered by growers in the locality a fair average annual loss. Where corrosive sublimate was used on cabbages the loss by maggot attack was less than 5 per cent. and the growth of the plant while somewhat better at the commencement of the year, was not appreciably different at the time of marketing the crop. The summarized results are given herewith:

TABLE I.— Cauliflowers—Averages and Summary.

Form of Treatment.	Percentage.	
	Affected by maggots.	Affected by other causes.
Tar paper discs	25.3	36.4
Corrosive sublimate—		
1 application, 1– 6	68.6	3.9
1– 8	62.0	8.0
1–10	64.0	16.0
2 applications, 1– 6	6.0	4.0
1– 8	62.0	8.0
1–10	64.0	16.0
3 applications, 1– 6	1.8	19.2
1– 8	....	23.4
1–10	1.8	19.0
No control	76.5	21.9

Life-History Notes.

Inasmuch as all previous study given the Cabbage Root Maggot in British Columbia has taken place in the Lower Fraser Valley, this year's work in the Armstrong district adds another locality where this insect has been under observation. The transplanting of the cabbages and cauliflowers was completed by May 3rd in 1919. The first adult flies were captured on May 7th in the field, and on examination of 100 plants on this day, only 3 eggs were taken. Oviposition was heavy previous to May 23rd and on this date small larvæ were found in the root systems of some plants that were showing signs of injury. Two large half-grown maggots were seen on this day also. Twenty-five plants were under more or less continuous observation during the early spring and on the dates May 12th and 13th and June 4th, these plants carried respectively 59, 847 and 1,091 eggs, the eggs on each examination being carefully removed by hand. It was exceedingly interesting to note that the largest plants received the greatest number of eggs and in view of the fact that the corrosive sublimate blocks contained the largest plants the blocks were the greatest attraction areas. The same point is drawn on page 27 of Bulletin No. 12 of the Dominion Entomological Branch, 1916, which details, so far as the bulletin relates to British Columbia, the life-history studies carried on in the Lower Fraser Valley. The sundry other points in the life-history of this maggot in the Armstrong district are so closely allied to the results detailed in Bulletin 12 on this insect that there is no need to take up further space in this paper for their discussion.

FURTHER DATA ON THE CONTROL OF THE CABBAGE ROOT MAGGOT IN THE OTTAWA DISTRICT.

ARTHUR GIBSON, CHIEF, DIVISION OF FIELD CROP AND GARDEN INSECTS; ENTOMOLOGICAL BRANCH, DEPARTMENT OF AGRICULTURE, OTTAWA.

Since the publication, in 1912, of our Bulletin on the cabbage root maggot* we have conducted a number of further experiments on the control of this insect, particularly with corrosive sublimate and tobacco dust and lime. The former has received special study during the past four years, and we consider its value to be undoubted and that it has now passed the experimental stage having been used with remarkable success under field conditions. Early references in the literature point to the fact that corrosive sublimate has been known as a remedy for the cabbage root maggot for over 50 years, and it is remarkable that its value has only been appreciated during comparatively recent years. In the years 1916 and 1917 we conducted experiments with corrosive sublimate on a small scale. In 1918, we used in one experiment 800 early cabbage plants. These plants were treated with corrosive sublimate in the strength of one ounce to four gallons of water on four occasions, namely, on May 27th, June 6th, 14th and 23rd. The results from this experiment were very striking, 96 per cent. of the plants treated with the corrosive sublimate being saved. In the same field in which the experiment was conducted the main cabbage plantation was destroyed by the root maggot to the extent of fully 60 per cent. In 1919, over 8,000 cabbage plants were placed at our disposal by Mr. J. I. Farquharson, who resides on the Aylmer Road, near Ottawa. Of this number 2,731 plants of the varieties Jersey Wakefield and Copenhagen Market were used in one experiment. This block of 2,731 cabbage plants was divided into 38 smaller blocks, of which blocks 1 to 18 inclusive, excepting blocks 2, 5, 8, 11, 14, and 17, which were left as checks, were treated with commercial corrosive sublimate mixture in the strengths of 1 oz. in 4 gallons of water, 1 oz. to 6 gallons of water, 1 oz. to 8 gallons of water, and 1 oz. to 10 gallons of water, some blocks having four treatments others only three. The plants were put out in the field on May 12th. The first application was made on the fourth day after planting, the second application six days later and one or two further applications ten days apart, about half a cupful of the mixture being poured around the base of the stem of each plant on each occasion. Each block consisted of 100 plants excepting the checks which varied from 20 to 36 plants each. Blocks 19 to 24 inclusive (100 plants each) excepting checks 20 and 22 (30 plants each) were used for felt-tarred-paper discs of various shapes. Blocks 25 to 23 inclusive (100 plants each) excepting blocks 26, 29, 32, 35, and 38 (20 plants each) were treated with tobacco dust and lime in the proportion of 1 part tobacco dust to 2 parts of lime, 1 part of tobacco dust to 3 parts of lime, and 1 part of tobacco dust to 4 parts of lime, two, three and four applications being made.

The results of this experiment are very striking. Briefly, they are as follows:

CORROSIVE SUBLIMATE. There was practically no difference in the plots treated with the various strengths of corrosive sublimate. The weakest solution, namely, one ounce in ten gallons of water, gave as good results as did the strongest mixture of one ounce to four gallons of water. Three applications, too, are apparently equal to four applications. The percentage of plants destroyed by the maggot

*Bull. 12, Ent. Br., Dept. Agr., 1916.

in all of these plots ranged from 0 per cent. to 4 per cent., whereas the plants in the check plots were destroyed to the extent of 52 per cent., 57 per cent., 61 per cent., 66 per cent., 70 per cent., and 80 per cent. respectively.

Discs Used. Hexagonal disc (block 19); small square disc (block 21); large square disc (block 24); and round disc (block 23). All gave excellent protection. In blocks 19 and 24 (100 plants in each) 100 per cent. results were obtained; in block 21 of similar size 1 per cent. destruction occurred and in the fourth block (23) 2 per cent. destruction. In the two check blocks, Nos. 20 and 22 (30 plants in each) the loss from maggot was 10 per cent. and 17 per cent. respectively.

Tobacco and Lime. One part tobacco dust and 2 of lime, also in proportions 1-3 and 1-4. Block 25, 1 to 2; Block 27, 1 to 3; Block 28, 1 to 4, (100 plants in each) had 4 applications about ½ to 1 inch of the mixture being placed around the stem of each plant. Block 30, 1-2; Block 31, 1-3; Block 33, 1-4 (100 plants in each) had three applications. Block 34, 1-2 (100 plants); Block 36, 1-3; Block 37, 1-4 (150 plants in each) had two applications. The percentage of plants in these blocks destroyed was also very small, varying from 1 per cent. to 4 per cent., the latter percentage being in Blocks 36 and 37 which received two applications only of the more diluted mixtures. Three applications of the mixture was practically as effective as four applications, and the weakest mixture gave practically as good results as the strongest. Check blocks (20 plants in each) with these series, were destroyed as follows: Block 26, 25 per cent.; Block 29, 20 per cent.; Block 32, 30 per cent.; Block 35, 30 per cent.; Block 38, 30 per cent.

A larger plantation of later cabbages, 3,360 in number, planted May 21st, was used for corrosive sublimate solutions solely. The plantation was divided into 11 blocks, 8 of equal size, each consisting of 378 plants, and the remaining three, which were used as check blocks, contained respectively, 105 plants each and one 21 plants. The corrosive sublimate was used in the same strengths as in previous experiment, namely, 1 oz. to 10 gallons water=1:1,280 (Block A, 4 applications; Block B, 3 applications); 1 oz. to 8 gallons water=1:1,024 (Block D, 4 applications; Block E, 3 applications); 1 oz. to 6 gallons water=1:768 (Block G, 4 applications; Block H, 3 applications); 1 oz. to 4 gallons water=1:512 (Block J, 4 applications; Block K, 3 applications). Blocks C, F, I and L were used as checks. Blocks A, D, G and J were treated on May 27th, June 4th, June 13th, and June 24th; Blocks B, E, H and K, on the first three dates only. In this experiment the time required to treat 3,000 plants was 3½ hours, using a watering can with spout closed slightly with wooden plug. In this experiment no attempt was made to keep a definite record of every plant. The blocks were examined at frequent intervals and from a practical standpoint no injury took place in those treated with corrosive sublimate. Conspicuous injury, however, was apparent in the check plots and the plants in these latter were certainly not as thrifty as those treated.

That the cabbage maggot was abundant in the immediate area of our work in 1919 was well evidenced by the losses which took place on the farms close by. Hundreds of plants of the early varieties were completely killed.

The above experiment following those conducted by us previously, particularly in 1917 and 1918, certainly strengthens the belief that in corrosive sublimate we have a valuable control measure for the cabbage maggot.

Cost of Treatments. In connection with the cost of treating cabbages per acre of plants with corrosive sublimate in comparison with cost of applying discs, it is of interest to record the following:

Corrosive sublimate.—Total cost per acre, including labor and material:	
3 treatments	$24.21
4 "	32.28
Tarred discs.—Total cost per acre, including labor and material	16.75

Effect of Corrosive Sublimate on Soil Bacteria. In order to determine the numbers of bacteria in the soil in the field where our cabbage maggot control work was conducted, bacteriological soil tests were made by an assistant, Mr. J. A. Flock, working under Mr. H. T. Gussow, of (*a*) soil treated with corrosive sublimate and (*b*) untreated soil. These soil samples were taken on August 18th, when most of the crop had been harvested. Briefly, the data resulting from these experiments clearly indicated that the corrosive sublimate treatment showed no deleterious influence either upon the plants or on the relative number of soil organisms present in the treated versus the untreated soil. Under field conditions the applications of the corrosive sublimate mixtures certainly seemed to have a stimulating effect upon the growth of the plants.

In the control measures conducted in 1919, Mr. J. A. Flock and Mr. W. P. Shorey, rendered valuable help.

CABBAGE MAGGOT CONTROL.

L. Caesar and H. C. Huckett.

In neither the Guelph nor Burlington districts did cabbages or cauliflowers suffer any damage worth speaking of in 1919 from the Cabbage Maggot (*Chortophila brassicae*). Only 14 plants out of 7,000 in the plot were killed by the maggots and these 14 were not in any one row but widely distributed over the field.

Fortunately we included in our experiments a plot of radishes, and as radishes were much worse attacked than cabbage some interesting and suggestive results were obtained.

We also devoted considerable time to trying to discover how corrosive sublimate controls the insect.

The results of the work along these two lines is given below:

TABLE SHOWING THE EFFECT OF VARIOUS

PLOT 1—COMPOSED

No. of row.	Date of sowing.	Date plants appeared.	Substance used.	Dates and strength of application.	No. of sound plants.
13	May 3	May 12	Check	Check	4
17	,, 6	,, 13	Check	Check	44
18 } 19 }	,, 6	,, 13	Tobacco dust 1 part and soot 2 parts..	May 14 and 26	90
20	,, 6	,, 13	Corrosive sublimate.	May 7—1 to 640 May 26—1 to 1,000	128
21	,, 6	,, 13	Corrosive sublimate.	May 7—1 to 640 May 26—1 to 1,000	115
22	,, 6	,, 13	Tobacco dust	May 14	55
23	,, 6	,, 13	Tobacco dust	May 14 and 26	34
24	,, 6	,, 13	Tobacco dust	May 14 and 26, and June 10	45
25	,, 6	,, 13	Check	Check	42
26	,, 6	,, 13	Soot	May 14 and 26	11
27a	,, 6	,, 13	Salt (dry)	May 26	8
27b	,, 6	,, 13	Salt (solution)	May 26	10
28	,, 6	,, 13	Corrosive sublimate.	May 7—1 to 640 May 26—1 to 1,000	75

PLOT 2—MEDIUM

No. of row.	Date of sowing.	Date plants appeared.	Substance used.	Dates and strength of application.	No. of sound plants.
32	May 26	May 30	Check	Check	121
33a	,, 26	,, 30	Corrosive sublimate.	May 31—1 to 240	44
33b	,, 26	,, 30	Corrosive sublimate.	May 31—1 to 480	49
33c	,, 26	,, 30	Corrosive sublimate.	May 31—1 to 720	60
33d	,, 26	,, 30	Corrosive sublimate.	May 31—1 to 1,000	58
34	,, 26	,, 30	Soot	May 31	64
35	,, 26	,, 30	Soot	May 31 and June 7	100
37	,, 26	,, 30	Ammonia	May 31, 1 to 16 of water	....

PLOT 3—LATE

No. of row.	Date of sowing.	Date plants appeared.	Substance used.	Dates and strength of application.	No. of sound plants.
4	July 8	July 16	Corrosive sublimate.	July 8—1 to 500	96
5	,, 8	,, 16	Corrosive sublimate.	July 16—1 to 1,000	78
6	,, 8	,, 16	Corrosive sublimate.	July 8—1 to 500 July 26—1 to 1,000	88
7	,, 8	,, 16	Check	Check	48
8	,, 8	,, 16	Corrosive sublimate.	July 8—1 to 500	96
9	,, 8	,, 16	Corrosive sublimate.	July 16—1 to 1,000	62
10	,, 8	,, 16	Corrosive sublimate.	July 8—1 to 500 July 16—1 to 1,000	115
11	,, 8	,, 16	Check	Check	28
12	,, 8	,, 16	Tobacco dust, sulphur and arsenate of lead	July 8	24
13	,, 8	,, 16	"	July 8 and 16	37
14	,, 8	,, 16	Carco	July 16, 23 and 30	33

SUBSTANCES UPON RADISH MAGGOTS.

OF EARLY RADISHES.

No. of wormy plants.	Per cent. wormy.	Remarks.	No. of row.
38	90.4	Roots not nearly so good as in corrosive sublimate rows.	13
94	68.1	" " " " " " " "	17
201	69.1	Vigorous foliage, long, rough, slender, poor quality roots.	18, 19
17	11.7	Moderate foliage, large, globular, smooth, good quality roots.	20
18	13.5	" " " " " " " "	21
50	47.6	Vigorous foliage, long, slender, rough, poor quality roots.	22
68	67.9	" " " " " " " "	23
70	60.8	" " " " " " " "	24
79	65.2	Roots not nearly so good as on corrosive sublimate rows.	25
50	81.9	Roots like tobacco rows, much inferior to corrosive sublimate.	26
30	78.9	Not a good test.	27a
25	71.4	" " "	27b
37	33.0	Mostly surface injury; good roots for table purposes.	28

EARLY RADISHES.

No. of wormy plants.	Per cent. wormy.	Remarks.	No. of row.
121	50.0	Not so good roots as on corrosive sublimate rows.	32
0	0.0	Good quality of roots, growth of young plants checked at first	33a
0	0.0	" " " " " " " "	33b
3	4.7	" " " " " " " "	33c
1	0.9	" " " " " " " "	33d
82	56.2	Foliage good, roots not so good as corrosive sublimate rows.	34
128	56.1	" " " " " " " "	35
0	0.0	All plants killed; same result later where 1 part to 32 of water was used.	37

RADISHES.

No. of wormy plants.	Per cent. wormy.	Remarks.	No. of row.
20	17.2		4
7	8.2	Note: The later application gave the better results.	5
4	4.3	Note: The two applications gave better results than one.	6
15	23.8		7
27	21.9		8
12	16.2	The later date here again gave better results than row 8.	9
8	6.5	Note: Two applications better than one.	10
12	30.0		11
15	38.4		12
18	32.7		13
9	21.4		14

Inferences from the Above Table and from Observations in the Field.

First. Corrosive sublimate was the only substance used which gave satisfactory or fairly satisfactory results, the results from it being better than the percentages indicate, because nearly all the injuries were on the surface, only a few being deep in the tissues, whereas in the checks a considerable percentage were deep in the tissues. The plants were somewhat older than usual when pulled. This possibly accounts for surface injuries.

Second. Tobacco dust alone, or soft coal soot alone, or a combination of the two, or a combination of tobacco dust, sulphur and arsenate of lead powder, gave no control and in most cases seemed to encourage the presence of the insect.

Third. Under conditions such as we had last year, corrosive sublimate had a decidedly beneficial result upon the size, shape and quality of the radishes causing them to be smooth-skinned and of good size. On the contrary, tobacco and soot both acted as fertilizers and gave excellent foliage but inferior form and size of the enlarged part of the root, this being elongate, slender, rough on the surface and unattractive in appearance.

Fourth. Corrosive sublimate if applied stronger than 1-1,000 to young plants, weakens them and causes a distinct shock, though they soon outgrow this. The same thing happens to cabbages if the roots, when being transplanted, are soaked a couple of minutes in the liquid, yet even then they recover. Too heavy soaking of soil around very young plants in the field, even with 1 to 1,000 may cause a sickly appearance of foliage for a few days.

Fifth. Sufficient tests have not been made yet to allow a reliable conclusion to be formed as to the best time to apply corrosive sublimate to radishes.

Sixth. Corrosive sublimate applied within 24 hours of sowing the seed appears to have no injurious effect upon germination.

How does Corrosive Sublimate Act in the Control of the Cabbage Maggot?

1. Does it Kill the Eggs? Eggs were placed on blotting paper in pill boxes containing soil freshly saturated with corrosive sublimate 1-1,000. The result was that of 80 eggs treated, 64 or 80 per cent. hatched. In the check, out of 134 eggs, 128 hatched or 95 per cent. The above results represent not a single test, but a series with a few eggs at a time. There seems no doubt therefore, that if the eggs hatch under these circumstances, they would hatch in the field in soil treated with corrosive sublimate.

2. Does it Kill the Larvæ? Various methods were employed to test whether corrosive sublimate kills the larvæ in any stage of their growth.

Out of 190 larvæ treated 83 pupated, 4 remained larvæ to the end of the test and 103 or 56.8 per cent. were missing. More would have been missing had they not in some cases been put in retainers from which they could not escape.

In the checks, out of 46 larvæ, 35 pupated and 11 or 23.8 per cent. were missing, 5 of these by accident.

Some of the missing treated larvæ were doubtless killed, especially the very small larvæ, but most of them crawled away and escaped. Where the larvæ were confined so that they could not escape, it was found that, while a good many died, yet many lived. It was observed however, that there was an evident desire both of large and small larvæ to avoid contact with this liquid compared with water. *Our inference* is therefore, that control is not to any large extent brought about by the death of the larvæ from contact with corrosive sub-

limate, but possibly from its repellent action, which causes the larvæ to wander away from the plant and thus perish. Larvæ, however, once well inside the plant, do not seem to be affected.

3. Does it Kill the Pupae? Three flower pots filled with fine sandy soil were sunk in the soil this spring and then thoroughly saturated with corrosive sublimate. Pot 1 contained 100 puparia and was saturated with 1-1,000 strength.

Pot 2 contained 100 puparia and was saturated with 1-1,000 strength.

Pot 3 contained 35 puparia and was saturated with 1-240 strength.

Eight other pots containing in all 885 pupae were left untreated and served as checks.

Results.

Pot 1 of the treated puparia gave an emergence of 11 flies.
Pot 2 of the treated puparia gave an emergence of 47 flies.
Pot 3 of the treated puparia gave an emergence of 2 flies.
Total emergence from treated pots 60=25.5 per cent.

From the 885 pupae in the checks 174 flies, or 19.6 per cent. emerged. We can therefore only conclude that corrosive sublimate does not kill the pupae.

Incidentally it may be mentioned that from the 885 untreated pupae, 424 cynipid and 15 staphylinid parasites emerged, and from the 235 treated puparia 20 cynipids and 1 staphylinid.

THE PRESENT STATUS OF MILL-INFESTING PESTS IN CANADA.

E. H. Strickland, Entomological Branch, Ottawa.

The Entomological Branch of the Dominion Department of Agriculture is undertaking a series of investigations and experiments upon the control of the insect and other pests of flour mills, bakeries, elevators and warehouses. This has necessitated a preliminary visit to representatives of these various industries throughout the Dominion for the purpose of ascertaining what are the most important pests, and the effectiveness of methods already in operation for their control.

In so far as the flour mills are concerned one pest, namely, the Mediterranean Flour Moth (*Ephestia kuehniella*), so far exceeds all other classes of mill pests in the trouble it causes, that the majority of millers look upon it as the only one meriting serious consideration. One of the favorite breeding places of this pest is inside the legs of conveyors, where the larvæ spin a voluminous mass of silk, which collects large quantities of flour and dust. If no precautions are taken this, in time, entirely clogs the elevator, which must then be dismantled and thoroughly cleaned.

One other group of mill pests—the Flour Beetles (*Tribolium* spp.)—is almost as prolific in Canadian mills as is the moth, but since these beetles do not interfere with the milling process they are, unfortunately, inclined to be tolerated in the various parts of a mill which they inhabit. From the millers' point of view this is readily understood. The moth is a serious menace to the smooth running of the mill. Hence its control is of great, sometimes even of vital, importance to the operation of an infested mill. The beetles on the other hand do not inconvenience the miller, and they are readily sifted out of flour, which apparently

leaves the mill in as good condition as if it had never been in contact with them. Suppose, however, one takes a sample of flour which is, to all appearance, in good condition from the mill badly infested with these beetles, and places it in a tightly closed tin, thus assuring that no beetles can obtain entrance for oviposition. An examination of this tin, say in six months' time, will in all probability reveal the presence of a large number of beetles. This is due to the fact that the beetle lays its eggs in such places as the inside of spouts, and in elevator boots. Thus the presence of the beetles results in the contamination of passing flour with eggs. They measure about 1/60 inch in diameter and could never be detected in the flour.

The owner of a badly infested mill rarely experiences any trouble with his flour, since he stores it for a very short time, and when it leaves his warehouse it is, in so far as he knows, a perfectly clean consignment. Should this flour be sold for local consumption it will probably be sterilized by being baked before the newly hatched larvæ have attained a sufficient size to attract the attention of their consumer. If, on the other hand, the flour is exported to some such warm climate as that of the West Indies, the time which must elapse, together with the temperatures at which it will be kept, before it arrives at its destination, offer every opportunity for the completion of at least the greater part of the beetle's life cycle. A further delay in the consumption of this flour may allow the completion of several generations, with the result that the consignment becomes seriously infested. Such conditions may not often occur, but prior to the general adoption of control measures, complaints were more frequently made of infestations developing in consignments of exported flour. Hence, from a national point of view, it is seen that mill pests have a greater significance than merely in so far as they affect the mill in which they live and breed.

Fortunately, we have at our disposal several means of reducing to a minimum, if not in all cases entirely eradicating, these pests, and the majority of millers have shown great energy and enterprise in adapting these remedies to their mills. The most important control measures are: superheating, fumigating and freezing.

Superheating is a method of control based upon the observation that a temperature of about 120° Fah. will destroy any stage of insect life in a very short time. A mill in which the pests are controlled by superheating is usually fitted with sufficient permanent steam pipes to raise its "room temperature" to about 130°F., but similar results can be obtained with the aid of temporary coils, and by utilizing the heat from a drier.

Heating is most conveniently effected over a week-end. When the mill closes down on Saturday night all elevator boots, etc., are opened up to allow a free circulation of air, and the heat is turned on. By the following morning the required temperature is obtained, and by preference it is maintained for over twenty hours. This duration of time is not necessary for the destruction of exposed pests, but it is desirable in order to assure that the heat penetrates into all accessible places. Work can be resumed on the Monday, though the first part of this day is usually occupied in giving the mill a thorough cleaning down. The result of this treatment is that all species of mill pests, in whatever stage they were present, have been destroyed in every part of the mill which was raised to a temperature of 120°, whether such places were accessible to a free circulation of air or not. Superheating is becoming increasingly popular with millers, and it is significant that only those who have never employed it are able to advance serious objections to its use.

Fumigation with hydrocyanic acid gas is a control method which served a very useful purpose before the superheating process was perfected, but it must now be relegated to the "out-of-date" class, since it has the following disadvantages when compared with the rival method: 1. It is dangerous to human life. 2. While the initial expense is less than that of installing an efficient heating system every subsequent operation is far more expensive than that of turning on the steam. 3. The gas fumes are less penetrating than the heat, and since a high concentration is required for the destruction of eggs many of these, which are laid in protected places, may escape. 4. The mill must be idle for a longer period at each operation.

Freezing is a method much in vogue in the Prairie Provinces, where extremely low temperatures can be relied upon at almost any time in the winter. When there is so much of this "natural resource" annually going to waste it would seem to be desirable that it be utilized to the greatest extent possible. We have no records of experimental data as to what low temperature is necessary to destroy the different stages of the various pests, and there is some doubt as to whether the extreme cold experienced in this country will destroy all of the stages. Some of the smaller mills do not run at all in the winter but they never appear to be quite free from pests when they commence operations in the spring. This may, however, be due to an annual re-infestation.

A mill, when it is opened up to freeze for a couple of days, is usually submitted just before or after the operation to a more vigorous cleaning than it receives at any other time in the year. To what extent the evident benefit derived can be ascribed to the cold or to the broom is a debatable point. Adults of the moth and the beetle certainly perish without exception at 25° below zero, but we have no definite data as yet upon the effect on immature stages.

Freezing is, in most cases, acknowledged to be hard on the mill. Steam pipes obviously must be completely drained, and this is not always easy. Some lubricating oils stiffen up at low temperatures, and the mill should not be re-started until it has warmed up to normal temperature. Metal work warms up more slowly than the rest of the mill. This results in sweating, which collects dust and may even cause rust. These difficulties have been overcome in several mills, among them some of the largest in the country, and freezing is practised by them with evident success. The first cold snap of winter is, however, usually rather anxiously awaited in such mills since, by the time it arrives, the moth is often "getting pretty numerous again." This is the main disadvantage to freezing as the sole method of controlling pests. It cannot be applied at any season of the year, and is not available in the summer when the moths are most active. It is, however, to be hoped that an opportunity will be offered this winter for us to obtain some definite data upon the value that low temperatures have in the extermination of mill pests.

These, then, are the chief methods of reducing the pests in our mills, but we are faced with one more problem in this connection, namely, that of re-infestation. This possibly is the main problem, and certainly, had it been solved in the first place, the problems of eradication would have been non-existent, for mill pests are not indigenous to mills. Some of the newest mills in the country have been heavily infested almost as soon as they were put into commission, while some others have remained almost free after many years of running.

Often this infestation, and re-infestation after eradication, is well-nigh unavoidable. A city mill with a local trade stands little chance of immunity,

but a large isolated mill, catering mainly to export trade, should avoid infestation if proper precautions are taken.

In probably 90 per cent. of the mills now infested with moths the pest has been introduced in second-hand bags. These bags are rarely taken into the mill. In most cases they are dumped into the adjacent warehouse to be used for feed stuffs. Sometimes they are cleaned with beaters or by suction, but a few eggs are liable to escape destruction by either treatment. More often the bags are not treated at all. In either case, the warehouse sooner or later becomes infested and it is only a matter of time as to when the pest will appear in the mill itself. The moths are rather unwilling fliers but they are very tame and are readily conveyed from one room to another on the clothes of people passing back and forth.

The remedies which are suggested for this means of infestation are:

(1) To avoid using second hand bags entirely. This, however, is not often practicable, except in the case of manufacturers of special brands of breakfast foods, whose reputation would suffer immeasurably were they to be unfortunate enough to distribute a consignment of "buggy" cereals among an unforgiving public.

(2) To sterilize by heat all second-hand bags before they are allowed to enter the warehouse. The bags should be allowed to accumulate in a small detached building which can be superheated say, once every two weeks; after each operation all of the contained bags should be transferred to the warehouse before more are admitted.

For a new uninfested mill such a method would pay for its small initial cost in a few months. In so far as we are aware, this method is not actually in use as yet in any mill, though it is "under construction" in at least one plant.

(3) To superheat the warehouse as well as the mill. This method would entail too much expense to be practised for most mills, though it would be of great value.

Generally speaking, then, millers throughout the country are keenly alive to the questions relating to the control of pests, but it would seem that a little more attention might be paid to the problem of avoiding re-infestation of a mill once it has been effectively cleared of its present unwelcome guests.

SOME NOTES ON THE LIFE HISTORY OF OUR COMMON JUNE BEETLES.

H. F. Hudson, Dominion Entomological Laboratory, Strathroy.

The white grub, the immature form of the May or June beetle, is one of the most important and most injurious of soil-infesting insects, and one of the hardest to control, on the sand and sandy loam soils of Western Ontario. They may occur occasionally in clay soils, but I have never observed or known of any injury by these insects on the heavier types of soil. Since 1914, observations on the life history of these important insects have been under observation, and though the work has had a chequered career, we have been able to breed out from the egg, the complete life history of three species. So far as our collection of beetles is concerned, and that involves many thousands, we have in Middlesex County seven distinct species, but probably only four are really common, although no extensive collections of beetles have been made outside of Caradoc Township. This is somewhat to be regretted as it does not give us a proper idea of the distribution of the different species. The seven species known to exist in Middlesex County are *L. fusca, L. rugosa, L. dubia, L. gibbosa, L. marginalis, L. ilicis,* and *L. inversa.* The three species raised from the egg are *L. dubia, L. rugosa, L. gibbosa.* The year 1914 was an excellent year for the collection of beetles, thousands were present, and ash, willow and butternut trees, were freely stripped of their foliage, while the early blossoms of cherry trees were freely fed on by the beetles. Coming early in May, the time of appearance being governed largely by temperature the beetles soon pair, frequently before they have eaten anything, but from observation eggs are not laid until from two to three weeks after fertilization. The female pairs frequently, at least I have seen the same pairs frequently in copula in their breeding cages. Pairs taken in copula May 16th, 1914, did not lay eggs until June 16th, but this was possibly due to my negligence in omitting to place a piece of sod in the breeding cage for the female to oviposit in. I noticed the day after the sod was introduced eggs were laid. The eggs are small, oval, of a pearly white lustre, each deposited singly in a ball of earth from 2 in. to 6 in. below the surface. After having been laid several days the eggs increase slightly in size, probably due to the absorption of moisture, become spherical in form and change to a reddish colour just prior to hatching. Our breeding cage records show that eggs hatch in from ten days to three weeks with an average of two weeks. This is somewhat difficult to gauge as we have noticed breaking open the little balls of earth to ascertain the egg yield, has undoubtedly a detrimental effect on the vitality of the young grub. The work of 1914 was practically concluded owing to the war, and although an assistant was procured in 1915, the results of the previous year's work amounted to nil. With the appointment of Mr. H. G. Crawford in the spring of 1916 the work obtained a new lease of life and much of the success of this work is due to his untiring and unceasing efforts. Starting with two species the results of that work were carried through to completion in the fall of 1918. On my return in the spring of 1917 the work was enlarged and additional species studied. We have now definitely ascertained the life history of *L. gibbosa, L. rugosa,* and *L. dubia* to be at least three years and in some cases it may be four.

The grubs feed most ravenously during the second and third year of their growth, prepare to pupate the latter part of July or early August of the third year

and produce the adult early in September where it lies comfortably in its earthen cell 6 to 8 in. below the surface until the advent of warm spring weather. In 1914 some 8,370 beetles were collected from various trees and shrubs, and a summary of the collection data thus obtained is worthy of mention. *L. gibbosa* is about the earliest species to appear in numbers and is very abundant until the middle of June when its numbers begin to decrease although scattering individuals may be taken until the middle of July. In fact the species comprise 66 per cent. of all beetles collected that year. In point of numbers the males exceed the females in the proportion of 1.74 to 1 or nearly twice as many males as females, the collection from lights and trap lanterns have not been included.

L. rugosa. This species appears about a week later than *gibbosa* and is not an abundant species, it feeds freely on the foliage of most trees. In point of numbers the males exceed the females in the proportion of 1.78 to 1.

L. fusca. Appears about the same time as *gibbosa* but is not so abundant in the early part of the season. Taking the season through it is next to *gibbosa* in order of abundance. The proportion of males to females in this case is reversed, the females predominating in the proportion of 1.47 to 1.

L. dubia. One of the first species to appear in spring but not common. Its season would seem to be shorter than any other species, no specimens having been taken after the 24th June. Females were more abundant than males the former predominating in the ratio of 2.2 to 1.

Notes on Collecting. There are some points of interest in collecting that are worthy of mention. In May and early June the beetle movement is quite regular, and the evening migration takes place usually a few minutes before 8 p.m., and is usually complete in 15 or 20 minutes. They are most abundant on warm nights with a temperature between 65 and 70 degrees, and the best time for collection is between 11.30 p.m. and 1.30 a.m. Likewise the return migration to the ground is similar, and is usually complete by 4 a.m. It seems to be governed by the brightness of the morning and as "West" (8th report 111. State Ent.) has pointed out, it seems as though the first bird note were a signal for the beetles to fly to their day-time hiding places. Should the temperature be not over 60 degrees, collecting may be safely begun by 9 p.m. as the beetles are not over active at that temperature, but should it be above that it is better to wait a little, until the beetles are less active as they are strongly attracted to lights, and will fly to the light or assemble on the collecting sheets from all directions and from all varieties of trees. The earlier in the evening collections are made the more beating the branches require, while if it is delayed, say until midnight or a little later, the least touch will cause the beetles to fall. It seems as though the cool night air has a stupefying effect, and once dislodged they make no effort to rise again. Collecting from trees inhabited by June beetles does not always indicate that they feed upon that particular plant, as I have ascertained. For instance, on May 18th a soft maple tree was found to be alive with June beetles, and the noise was like the hum of swarms of bees, yet on examination the following morning, no injury of any consequence was observed, except that an occasional outside margin of a leaf had been slightly eaten. Their sole object in thus assembling in this tree was principally for copulation purposes. Their habits in the daytime are equally interesting, leaving their food plants early in the morning, they hide themselves in tufts of grass, or in the soil ½ to 1 in. deep. A heavy rain will keep them in their daytime hiding places, but a light rain will not interfere with their movements. Should a heavy rain come on while they are feeding it has the effect of

making them less attractive to lights. Temperature is a very important factor, the lowest temperature I have recorded when collections were made was 47 degrees at 9 p.m. At this temperature beetles are very scarce.

Control Measures. We have been rather unfortunate in securing much information on the natural control of these insects. It is a matter of common observation that crows, blackbirds and domestic poultry feed readily on the young grubs, while skunks undoubtedly also relish them. On several occasions we have reared the tachinid *Microphthalma disjuncta* and probably *Pelecinus polyturator*, although the specimen is not perfect. On two occasions in badly infested fields I collected a number of cocoons of a digger wasp, presumably *Tiphia inornata*, but have not been very fortunate in rearing them out. With the scarcity of birds and other natural agencies of control, the question of suppressing an outbreak seems to be one of agricultural rather than entomological procedure. From a careful survey of the crop rotation on several farms in Caradoc Township, it would seem to indicate that arable land should not be in pasture more than two years and a definite system of short crop rotation followed. The following rotation followed on one farm is of particular importance, in that not only is the fertility of the soil increased, but since the adoption, there has been no injury whatever by white grubs or any other insect. First year oats, seeded to clover, hay crop removed, land planted to wheat, seeded to clover again and planted again to potatoes and corn. Here we have two clover crops in four years and no crop longer than one year on the ground. This, of course, is only applicable to arable land, the question of old pastures is still a perplexed problem, except when brought under cultivaton. Trapping the beetles by the use of lanterns is hardly applicable, because fully 75 per cent. of such collections are males. It would appear that short crop rotations, frequent growing of clover, and clean farming will do more to decrease the spread of this insect than any other means.

REPORT OF THE INSECTS OF THE YEAR—DIVISION NO. 6.

H. F. Hudson, Strathroy.

Weather conditions in Western Ontario have been both favorable and otherwise to insect life. The spring was cold and very wet, this was followed by a hot and very dry summer. A brief summary of the more important injurious insects is appended below:

Clover Leaf Weevil (*P. punctatus*). In the low-lying pasture fields south of London, Ont., more especially in and around Delaware Township, clover and timothy fields were most heavily infested with this weevil. They were present literally by millions and probably no such heavy infestation has ever been witnessed in this section before. Every blade of timothy had a grub curled around it and every clover leaf was badly riddled with small holes and over seventy grubs were taken from a single clover plant. Fortunately the extremely wet weather produced a fungus disease amongst them and in less than a week the whole outbreak had subsided.

Cutworms. These insects have been responsible for considerable injury and in nearly all cases the culprit has been the "glassy cutworm." In nearly all cases the affected field was an old sod.

Potato Flea Beetle (*Epitrix cucumeris*). Extremely abundant this year but is readily controlled by spraying with arsenate of lead.

Potato Beetles (*Leptinotarsa decemlineata*). Probably more abundant this year than usual, but late planted potatoes were scarcely injured; in quite a number of cases potatoes planted in late June were not sprayed at all.

Potato Leaf-hopper (*Empasca mali*). An old pest in a new guise. The potato crop in Western Ontario has been considerably reduced in yield, in some cases I should say at least 25 per cent., due to the ravages of this insect. Classed as a new pest by potato growers adequate means of control were not generally known; consequently the insect had almost its own way. I have had partial success by the use of "Black Leaf 40" and soap, using one tablespoonful of the nicotine solution to one gallon of water plus two ozs. soap.

THE STRAWBERRY ROOT WEEVIL IN BRITISH COLUMBIA.

W. Downes, Victoria, B.C.

Of the many many insects that trouble the small fruit grower perhaps few equal in destructiveness the Strawberry Root Weevil (*Otiorhynchus ovatus* Linn.). Within the last ten years or so its prevalence in the strawberry-growing sections of the British Columbia mainland and Vancouver Island has been a matter of increasing concern to the planters, and in some of the districts where the industry has been longest established it became a question whether its profitable continuance could be any longer maintained.

In Oregon in 1912 some work was done in the study of the Weevil by Prof. A. L. Lovett[1] and notable work was done in British Columbia in 1913 by Mr. R. C. Treherne[2] who established the main principles for its control. During the last two seasons further studies on this insect have been made by the writer in the Gordon Head district of Vancouver Island and some new information regarding its life-history has been brought to light.

The strawberry-growing sections of Vancouver Island are mainly areas of light sandy soil on which the berries seem to do better than on heavier land, though here and there one finds plantations on stronger soil, usually on the lower levels. Cultivation is on the hill system. The worst infestations were found always on the light land, the reason probably being that such soils provide the best facilities for penetration by the young grubs. The degree of infestation usually varied according to the age of the plantations, one-year-old fields being frequently free or showing an average infestation of one or two weevils to the hill. Two-year-old fields would average three or four times that number, while the highest numbers were nearly always recorded from three-year-old fields. This is, however, not by any means a general rule, as much depends on the proximity of young fields to older plantations and cases were found where one-year-old fields adjacent to an old plantation were badly infested, and in 1918 a two-year-old field of five acres was totally destroyed. This field in 1917 produced 2,000 crates of berries; in 1918 only forty were gathered. In this case the owner had been growing strawberries on his farm for many years until a heavy population of weevils had concentrated there; moreover, the situation was aggravated by the practice of planting strawberries after clover sod, a proceeding calculated to provide the succeeding berry crop with a plentiful supply of weevils, as clover is one of the crops upon which the strawberry root weevil thrives.

At the present time, owing to general appreciation of the principles of control, the strawberry root weevil seems to be decreasing in the Gordon Head district. At Keatings, on the Saanich peninsula, a slight increase is reported, and on the Lower Mainland the situation is very much as it was some years ago with heavy infestations reported from certain points.

Origin and Life History.

Recent investigations show that the strawberry root weevil is undoubtedly indigenous and not introduced. Mr. R. C. Treherne[2] has found the weevil at various altitudes up to 4,000 ft. in the mountains and on isolated rocky islands several hundred yards from the mainland. I myself have found it in spots far removed from cultivated areas, and all the evidence tends to show that it is not an introduced insect but primarily a species infesting grasses and various forms of native vegetation. To the list of wild host plants of the larvæ given by Lovett[1] I am able to add two more, Snowberry (*Symphoricarpus racemosus*) and Oak on both of which I have found the larvæ in Victoria. It is a common pest in gardens and the grubs may be found attacking a great variety of plants.

To the list of cultivated plants attacked by the larvæ Red Clover must be added. I have found them very numerous in clover sod at Gordon Head, even in the spring, on sod that had been ploughed down the previous fall. Thus in any scheme of cultivation in which strawberries have a place it would be obviously unwise to plant them following a crop of clover. A suitable system of rotation will be referred to later.

Oviposition. Observations taken during two seasons at Gordon Head showed that the oviposition period extended from the middle of May to the middle of September. The eggs are laid promiscuously around the plants, sometimes against the crown itself, and often buried a quarter to half an inch below the surface. When a crevice in the soil is available this may be taken advantage of as a spot in which to deposit the eggs. Formerly it was supposed that all the eggs were deposited by those weevils which emerged in the summer, but I have this year conclusive evidence that the over-wintered adults also deposit eggs in large numbers. Commencing on April 1st, collections of over-wintered weevils were made at intervals up to June 13th and kept for observation. That these were true over-wintered individuals there can be no doubt, as the earliest date of the emergence of the summer brood at Gordon Head is during the last week in May, and this year adults were not found in the soil in teneral condition until June 13th. Throwing out of consideration those collected in June, we have four lots of over-wintered adults collected on April 1st, May 1st, May 19th and May 31st. The first lot collected commenced to oviposit on May 18th (probably later than under natural conditions) and those collected on May 19th commenced to oviposit on May 28th. All the lots continued to lay eggs throughout the summer until August 30th when oviposition ceased. The highest average number of eggs per individual was 198, laid by those collected on June 13th, and the next highest 130, laid by those collected on May 19th. The earliest lots collected laid very few eggs, averaging 12 and 28 respectively, this being perhaps due to artificial conditions. In the third week in August the weevils began to die rapidly and by the first week in September nearly all were dead.

Oviposition by Summer Brood. It was intended to make the study of this point more complete this year, but owing to an unfortunate accident to our

emergence boxes in the field, sufficient material was not obtained and the data were got from a limited number which were bred in the laboratory. These commenced to deposit eggs on July 20th, probably very much later than would be the case in the field. Under laboratory conditions the weevils are somewhat retarded and do not prove as healthy as those in the field. The vials were examined and the eggs counted every four days. The maximum number of eggs laid by an individual in this experiment was 249 and the minimum 73, while the average was 154, all deposited within a period of six weeks. Thus it will be seen that there are two broods depositing eggs simultaneously. In the case of both broods oviposition ceased at the same time this year but in last year's experiments many weevils continued to lay until the middle of September. Endeavour will be made another season to determine whether the same weevils oviposit twice. In no single instance as yet have I discovered weevils of the summer brood that did not lay eggs and therefore I assume that a proportion of the summer brood does not die but after ovipositing hibernates, and in the spring, after a period spent in feeding and development, oviposits again. If this is not the case, it is difficult to account for the origin of the numerous overwintered individuals.

Parthenogenesis. In all the experiments conducted here no male weevils have been discovered. Although about 200 specimens have been examined and dissected only those have been found possessing the genitalia proper to the female. Also among the large number kept in confinement none were ever found in copulation; neither has it been observed in the field. Consequently the belief has been held by us for some time that *O. ovatus* is parthenogenetic. This impression was strengthened by the recent discovery in France by J. Feytaud[4] that *O. sulcatus*, its near ally, was parthenogenetic, making the fourth Coleopteron known in which the method of reproduction is by parthenogenesis. To test the matter a number of pupae were collected in the field this season and isolated in vials. On reaching adult condition they were placed each in a glass vial loosely stoppered with cotton wrapped round with paper, and fed on strawberry leaves. The vials were kept in my house and examined at intervals of two or three days. At first cotton wool was used for vial stoppers but it was found that the weevils deposited eggs among the wool, making them very difficult to find. When the wool was wrapped in paper the difficulty was surmounted, although the beetles would occasionally deposit eggs in a fold of the paper. Oviposition commenced on July 20th and continued until August 30th. The eggs of each individual were kept separate. On August 24th larvæ were found to have hatched from eggs laid by weevil No. 5 and within a few days larvæ were also found in the other vials. Thus it appears evident that the weevil is parthenogenetic. *O. ovatus* thus makes the fifth coleopteron known to be parthenogenetic the others being *O. turca* Bohem, *O. cribricollis* Gyll, *A. ligustici* Linn., and *O. sulcatus* Fabr. Some individuals produced a larger proportion of infertile eggs than others, and it may be noted that twenty days elapsed between the time when the first food was given and the commencement of oviposition. This is a greater period than would occur in nature and in the experiments conducted by Treherne[2] the minimum period was found to be eight days. I attribute the difference to confinement and artificial conditions of feeding.

Incubation and Fertility. Experiments made to find the period of incubation showed that it varied from sixteen to twenty-two days.

The fertility of the eggs varied from 68 per cent. in the case of those laid by overwintered adults to 80 per cent. in the case of those laid by the summer brood.

Duration of Pupal Stage. This was found to vary from ten to twenty-six days. The adults commenced to harden at the end of twelve hours and are completely chitinized in seven days. One individual came to the surface in four days, but while able to climb was not completely hardened.

Emergence of the adults commenced at the end of May. In 1918 the first were taken in the cages on May 25th and the emergence continued until the end of June with a maximum during the second week in June. In 1919 the emergence was later, the first adults being found in teneral condition on June 13th and these would not normally emerge for another week. The season was colder than the previous one and this would account for the difference as the pupae are retarded by lower temperatures.

Migration. On the advent of warm weather in the spring there is a general movement of hibernated weevils from their winter quarters to their feeding ground. Every conceivable spot may be used by them in which to hibernate and where they are especially numerous, dwellings are frequently invaded by them to the consternation and annoyance of the owners. Piles of stones or logs, and fence lines overgrown with weeds and brush form ideal quarters, but where the winters are mild, as on Vancouver Island, many spend the winter among the crowns of the strawberry plants. The weevils begin to move in March and are fairly active until May when their migratory activities appear to lessen, after which, in June, their numbers are augmented by the newly emerging summer brood and a further movement begins which reaches its climax at midsummer, then lessening until late summer when they seek winter quarters.

Regarding the distance travelled by them in a season no definite evidence was obtained, but one new field at Gordon Head, eighty yards wide, was infested throughout in a single season, the weevils coming from an old patch adjoining. The young patch was bordered on three sides by bush so the weevils could only come from the side adjoining the old patch. On this side the average number of larvæ per hill was 27, in the centre 16, and at the further end 7. I would say, therefore, that the weevils would be likely to travel at least double the width of this patch, or from 160 to 200 yards.

Measures of Control. The observations made during the last two seasons have shown that the main principles of control as formerly laid down are undoubtedly correct. There is no poison or chemical treatment of any kind that we know of that can be applied to the plants without injury and will at the same time control the weevil. The question is a cultural one and the best results are obtained by a suitable rotation of crops, a double object being attained by discouraging the weevil and maintaining soil fertility. At Gordon Head the Provincial Government has leased six acres in a badly infested locality and is endeavouring to demonstrate a system suitable to the district. Briefly outlined this would be as follows: Presuming that we start with an infested field, the plants should be pulled up and burnt at the end of August or beginning of September. Leaving them until this time induces the adult weevils to remain in the field and deposit their eggs there. Then the field may be ploughed and should be kept fallow about a month, the spring-tooth cultivator being frequently used to bring out all strawberry roots that may remain. This proceeding will starve out all the young grubs in the soil. A suitable crop to sow the land to would be fall wheat with vetches or clover. The land may remain in clover two years and should then be fall ploughed and potatoes planted the following year. The next year the field may be planted back

to strawberries the land being clean and free from weevils as the potato is one of the crops on which they cannot live.

It is recommended that not more than two crops of strawberries be taken from a field under ordinary conditions. It is not only important not to overcrop the land, but leaving the land in strawberries too long allows the weevils to concentrate there and is inviting disaster. It is also important that judicious applications of barnyard manure be applied to keep the land in good heart. By growing vigorous healthy plants they will be in better condition to stand an attack of weevil and will recover more rapidly. As to the advisability of including clover in the scheme of rotation, we have doubts as to the wisdom of this owing to the danger of maintaining weevil in the land, but we know of nothing that will quite take its place unless it can be shown that it is equally profitable to grow peas or vetches or some other legume and still maintain the fertility of the soil.

The recent light thrown on the oviposition of the weevil emphasizes the necessity of destroying as many adults as possible. It is believed that chickens will prove of the greatest help in this matter and it is suggested that small lots in colony houses should be allowed to run in the plantations. They readily pick up the weevils and the good they do far outbalances the harm done by scratching among the plants. At blossoming time they may be shut up and allowed to run again after the crop is off. The difficulty in closely settled districts of preventing newly set plantations from being re-infested by adjacent old ones is a problem that we are attempting to solve by the aid of wooden barriers with a band of tanglefoot. These have been tried elsewhere and have been found to be partially successful and the results obtained at Gordon Head fully justified us in continuing our experiments. At the present time we have not gone sufficiently far to be able to say that they are commercially practicable but we believe they will prove a useful adjunct in weevil control.

REFERENCES.

(1) Lovett, A. L. Ore. Agr. Exp. Station, Bi. Hort. Rep., 1913.
(2) Treherne, R. C. Dom. Ent. Bul. 18.
(3) Treherne, R. C. Can. Ent., XLIX., No. 8.
(4) Feytaud, J. Comptes Rend. des Séances de l'Acad. des Sci., Vol. 165, No. 22. Paris.

THE STRAWBERRY WEEVIL.

W. A. Ross and C. H. Curran, Dominion Entomological Laboratory, Vineland Station.

The following paper is based largely on field observations made in 1918-19 and on preliminary experiments conducted during the past season in the Niagara and Oakville districts.

History and Distribution in Canada.

The strawberry weevil is a native insect, which, it is believed, bred originally in the buds of the redbud, the wild blackberry and wild strawberry.*

It has been known as a strawberry pest in Canada at least since 1886. In the Dominion Entomologist's Report for 1890, Mr. W. H. Hale, of Sherbrooke,

* Slingerland and Crosby, Man. of Fruit Insects, p. 373.

makes the following statement: "For several years I have been suffering from the ravages of some sort of insect which attacks the buds of all the staminate varieties of strawberries; a small puncture is made through an unopened sepal and an egg is deposited. The stalk is then partially or entirely cut through. . . . In a large field of strawberries in which 80 per cent. of the rows were pistillate varieties not a single bud was touched, while the remaining rows of strawberries were almost entirely denuded of buds. This same trouble was noticed in Staten Island and Hamilton, Ontario, in 1886. . . .".

Further reference is made to strawberry weevil outbreaks in succeeding reports of the Dominion Entomologist, and also in the reports of the Entomological Society of Ontario.

So far as we are aware the weevil is recorded as being injurious in only two provinces in Canada, viz: Ontario and Quebec.

Host Plants and Injury. In Ontario the strawberry weevil has been bred from the buds of the strawberry, raspberry and blackberry, and it has also been observed attacking wild strawberries and rambler roses. The dewberry, the redbud or Judas tree and the yellow flowered cinquefoil, are recorded by Slingerland and Crosby as being additional host plants of this species.

The injury is caused by the female weevil cutting off the flower buds, after depositing her eggs within them.

Strawberry. Occasionally the yield of strawberry plantations in Southern Ontario, especially in the Niagara District and Halton County, is seriously reduced by the weevil, or as it is commonly called, "the cutter." For example, in 1918 from 30 to 75 per cent. of the buds in some strawberry fields near Oakville and Jordan were destroyed by the pest. In a badly infested ¾ acre plantation at Jordan only nineteen crates, or 513 quarts of berries were harvested.

All the common staminate varieties are subject to attack. Varieties with imperfect or pistillate flowers are practically immune.

Raspberry. According to our observations the raspberry crop is never injured to any appreciable extent, chiefly, we believe, because at the time raspberry buds are put forth the overwintering adult weevils are fast dying out. This past season we examined several raspberry plantations adjoining strawberry fields, but even the worst attacked bushes had less than ten per cent. of the buds severed.

Blackberry. A patch of blackberries in the Vineland district was rather seriously injured by the weevil last spring, about 25 per cent. of the buds being destroyed. In the row next to an adjoining field of strawberries about 75 per cent. of the buds were severed. It was noted that frequently the weevil severed the cluster stem and thus, at one stroke, destroyed several buds.

As a general rule, however, weevil injury to the blackberry is negligible.

Roses. Mr. Bartlett, an Oakville fruit grower, observed the weevil—an insect with which he is very familiar—severing the buds of his rambler roses.

Life History.

Summary. The winter is passed in the adult stage, probably under vegetation and rubbish, in waste and bush lands adjoining the strawberry fields. In spring the insects leave their winter quarters and appear on the strawberry plants about the time the first buds are forming. By means of her slender snout the female weevil punctures the blossom buds, and deposits her eggs singly in the interior of the buds. After depositing an egg she then crawls down the blossom stem and cuts it so that the bud either falls immediately, or is left hanging for a few days, by

a thread. Within the severed buds the whitish grubs which hatch out from the eggs, feed on the pollen and other interior parts. They become mature in about two weeks, pupate, and emerge as adults during the latter part of June and throughout July. The new adults feed for a short time on the pollen of various flowers and, then in midsummer, they seek their hibernating quarters. There is only one generation a year.

The Adult.

Description. Oval, robust, brownish-red to blackish, thinly clothed with whitish pubescence, condensed on a medium line of the thorax and scutellum; elytra dark red, the denuded fascia and scutellar space darker. Antennal grooves directed against the eyes, funicle seven-jointed; antennae dull yellow, club darker. Beak longer than the head and thorax, slender, feebly curved, striate and punctate on the sides, carinate above. Thorax wider at the base than long, sides feebly rounded, narrowed towards the apex; disc densely and rather coarsely punctate. Elytra one-fourth wider at the base than the thorax, one-half longer than wide; striae rather deep, their punctures large, close set; intervals convex, finely punctulate. Ventral segments nearly equal, the third longer than the fourth; pygidium convex, not grooved. Front femora with one tooth, hind tibiae with a short spine at the tip, claws armed with an acute tooth. Length, 2-3 mm. (Adapted from Blatchley).

Emergence in Spring and Habits. The weevils appear in strawberry fields in May, about the time the first buds are formed. Last spring they were first observed in the Vineland district on May 14th. At this time the buds of Senator Dunlap were in evidence, but the buds of Williams had not yet been produced.

The insects eat out holes in the buds and feed on the pollen within. Often several punctures are made in a single bud, so that when the blossom opens the petals present the appearance of having been shot full of holes. The weevils also feed on the stamens of open blossoms and occasionally they eat out holes in the foliage.

So far as we could judge strawberry weevil adults are capable of flying only a few feet.

Egg Laying. In ovipositing the female chews a small hole through the bud, inserting the snout to the base. She then turns around, locates the puncture with her ovipositor, and deposits the egg within—usually among the stamens. In observing this process of oviposition we noted that sometimes two holes would be made, but that only one egg would be laid in the bud. After ovipositing the weevil crawls down the stem and cuts it, so that the bud either falls immediately, or, as is more commonly the case, is left hanging by a mere thread for a few days. The stem may be severed at the base of the bud, or further down. Infrequently the stem of the cluster may be severed.

In the field the adults were observed ovipositing first on strawberry, and later on blackberry and raspberry from May 14th to June 26th. However, it should be stated that by the time the raspberry buds appeared most of the adults had died.

The reproductive capacity of the female was not determined.

Effect of Cold Weather on the Weevil. This spring it was observed that during the cold, wet spell of weather prior to May 19th, the weevils were comparatively inactive, and little injury was done to varieties such as Glen Mary, which were in full bud during that period.

The Egg.

The egg is translucent, broadly oval, and is about 1/50″ in length. As previously stated, it is deposited within the bud and usually adheres to the stamens or pistils.

Duration of Incubation. In experiments with 100 eggs from May 28th to June 6th the duration of incubation varied from four to eight days, the average being six days.

Mortality. In experiments with 65 eggs from May 28th to May 31st the mortality was 14 or 21.4 per cent.

The Larva.

Description. Length, extended, slightly over 2-mm. Color, whitish-sulphurous, often mottled with blackish. Eyes sub-translucent, yellowish: mouth parts brown, lighter below. Thorax less roughened than the abdomen, of three

Adult of the Strawberry Weevil.

Strawberry bud opened to show egg of the Strawberry Weevil within.

distinct segments; narrow dorsal anterior margin of the first segment brownish. Legs wanting, but represented by six fleshy protuberances, each bearing three bristles, the middle one longer and slightly blackish; between the first pair of protuberances a narrow brownish stripe. Abdomen below more translucent, flattened, the sides produced slightly as a longitudinal fold. Above, the abdomen is deeply rugose: there are eight complete folds commencing at the lateral fold, each bearing two lateral, two sub-lateral and two dorsal hairs; between these, on each side a shorter fold, extending from the lateral fold to one-third the upper curve, and a second dorsal fold, commencing immediately before the dorsal termination of the lateral fold. The dorsal fold bears four hairs, the lateral, two. All the abdominal hairs are without color. Behind the thorax the abdomen is naturally curved beneath, so that the distal end rests below the thorax. Abdomen gradually tapering to the sub-apical segment, which bears the posterior respiratory organs beneath a sub-apical fold. Respiratory organs not at all projecting: a slender,

brownish-yellow transverse line runs across them. Last segment tapering, subconical, on each side with a very narrow yellow longitudinal line, from the base to near the tip; the extreme tip yellowish.

Habits. Within the severed bud the larva at first feeds on the pollen. Pollen, however, is not absolutely necessary for its sustenance, as is shown by the fact that we reared a few adults from buds of Sample, a pistillate variety. The grub feeds on the other interior parts of the bud and eventually bores its way into the receptacle, forming here an enclosed cell, the entrance to which is plugged with closely packed excreta.

Effect on Larva of Drying Out of Bud. In cases where the buds persist on the plants or dry out on the soil, the majority of the larvæ die. Last season only 11 adults were reared from 180 dried out buds.

Duration of Larval Stage. The average duration of the larval stage of 96 grubs was 13 days, the maximum and minimum periods being respectively 16 and 11 days.

Work of Strawberry Weevil. Note the severed buds and punctured petals.

The Pupa.

Pupation takes place within the bud. The pupa is creamy white, sometimes mottled with black. All the appendages of the adult are apparent.

Duration of Pupal Stage. In experiments with 90 pupae the maximum, minimum and average periods of pupation were respectively, 18 days, 6 days and 10 days.

Further Notes on the Adults.

Emergence From Buds. According to observations made during the past two years the adults commence to emerge from the buds about June 20th, and continue to emerge throughout the greater part of July.

Habits and Food Plants. In the insectary the newly emerged adults fed very freely upon the leaves of strawberries. On some of the plants practically all the foliage was devoured—little more than the bare ribs being left. In the strawberry fields, however, very few beetles were found attacking the foliage, and no

case of skeletonizing of the leaves was observed. Prior to July 14th the weevils were noticed only in strawberry patches. On that date, however, large numbers were found feeding on the flowers of milkweed (*Asclepias*) there being from twenty to seventy on each head. Later on the weevils were taken on the leaves of golden rod, and on the bloom of Canada Mint (*Mentha arvensis canadensis*), Catnip (*Nepeta cataria*), and Heal-all (*Prunella vulgaris*).

Slingerland and Crosby state that the weevil feeds on the flowers of wild bergamot (*Monarda fistulosa*); and Dr. Hamilton* mentions that it was taken feeding on the leaves and flowers of basswood (*Tilia*).

Hibernation. The beetles apparently go into hibernation in mid-summer. After the second week in August we found no more weevils feeding on flowers, nor did we find out where the insects went. Rubbish and long grass in the neighborhood of strawberry fields were searched, but no weevils were located.

According to Slingerland and Crosby the insects hibernate "under rubbish, particularly in wood lots or hedgerows adjoining strawberry fields." In Minnesota

Strawberry bud cut open to show the Strawberry Weevil grub feeding within.

the weevils have been found snuggled down about the base of strawberry plants, and in New Jersey they have been found in woodlands adjacent to strawberry fields resting upon the upright stems of a common moss.

Methods of Rearing.

Pill boxes were used for rearing the weevils from the egg to adult stage. A small amount of soil was placed in the box and kept slightly moist. Too much moisture, or too little, resulted in many cases in the death of the larvæ. The buds were secured in the field or from potted plants, and only buds which were observed being cut by the adults were used. In examining the bud, the sepals and petals were carefully raised, so as not to disturb the grub. It was found that this seldom resulted in any apparent injury to the grub, and it did not appear to deter its development. Where only the numbers developing from cut buds was desired, the buds were placed in a flower pot half filled with moist soil and covered with cheesecloth.

* Can. Ent. XXIV., p. 41.

Control.

The excellent results secured in New Jersey in the control of the strawberry weevil by the use of a dust preparation composed or powdered arsenate of lead and finely ground sulphur led us to give this remedy a trial. Two mixtures were tested (1) 100 sulphur, 20 arsenate of lead, and (2) 90 sulphur, 10 arsenate of lead.

Two strawberry fields at Oakville were treated by the junior writer, and one plantation at Vineland was dusted under our supervision. In addition to these a considerable number of strawberry patches in the Oakville and Niagara districts were treated by their owners. The applications were made by means of: (1) a Monarch duster, (2) a home-made twirler,* and some of the growers used cheese-cloth bags.

The dust was applied, weather permitting, as soon as the weevils were found in large numbers. The Bartlett patch at Oakville, and part of the Church patch at Vineland, were dusted twice on account of the first application being washed off by rains, but all the others received only one application.

Results.

W. Bartlett, Oakville. The weevil has been injurious to Mr. Bartlett's strawberries for a number of years and this spring the adults were again very abundant in his patch and threatened to cause serious loss. The two dust mixtures mentioned above were tested and two applications were made.

Results. No more than 5 per cent. of the buds in the whole patch were destroyed and Mr. Bartlett picked the largest crop of berries he had ever harvested. No marked difference was noted between the rows dusted with the 100:20 mixture and those with the 90:10.

As this was the main experimental patch we arranged to leave an adjoining berry patch untreated as a "check." However, Mr. Bartlett found the weevil hard at work in our "check" patch, and decided very suddenly that he was more interested in dollar and cent returns than in experiment results, and he gave what was to have been our "check" patch a heavy coat of dust.

R. Burton, Oakville. Last year (1918) at least 75 per cent. of the buds were destroyed in Mr. Burton's two-acre patch of Glen Mary strawberries. The two dust mixtures were tested this year and only one application was made.

Results. Here again there was no difference in the amount of injury between the rows dusted respectively with 100:20 and 90:10. Throughout the whole of the patch no more than 10 per cent. of the buds were destroyed, and at least half of this injury was done before the dust was applied.

It should be mentioned that in our estimation this particular experiment was of little value because in all cases which came under our observation this year, the variety, Glen Mary, escaped serious injury.

S. Church, Vineland. Last year over 50 per cent. of the buds in Mr. Church's patch were destroyed, and this spring the weevils were present in large numbers. Several rows of early berries were dusted twice. However, the main patch of Williams only received one application. Only the one dust, the 90:10. was used.

*The frame work of the holder was made of a wire ring 9"-10" in diameter and two bent wires crossed at right angles. This was lined with fine wire cloth, twenty or more meshes to the inch. A bent branch was used as a handle.

Results. An insignificant percentage of the buds were destroyed in this patch and a splendid crop of berries was harvested—about 250 crates per acre. In a patch about ¼ mile from Mr. Church's at least 60 per cent. of the buds were destroyed by the weevil and the yield was only 100 crates per acre.

Results in Other Strawberry Patches.

In every strawberry field where the dust was put on at the right time excellent control was obtained. All the growers who used the dust remedy expressed themselves as being well satisfied with the results.

INSECTS OF THE SEASON IN ONTARIO.

W. A. Ross, Dominion Entomological Laboratory, Vineland Station, and L. Caesar, Ontario Agricultural College, Guelph.

The past year was a notable one from the entomologist's point of view. The mild winter of 1918-19 and the hot, dry summer were very favourable to insect life, and consequently injurious insects of many kinds were numerous.

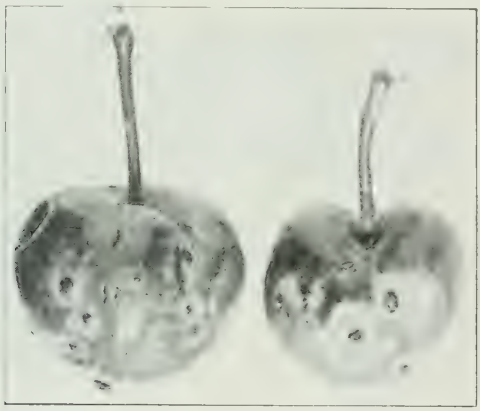


Fig. 1.—Young apples deformed by nymphs of the Mullein Leaf Bug (*Campyloma verbasci*).

Orchard Insects.

It is worth while noting here that the carefully and regularly sprayed apple orchards were practically the only ones which had crops of fruit this year.

Codling Moth (*Cydia pomonella*). This well-known pest was very much more abundant than usual and caused great loss in the warmer parts of the Province where the percentage of second brood is largest. Some unsprayed orchards in the Niagara District had almost every apple infested. Orchards, well sprayed this year, but which in preceding years had been neglected or poorly sprayed had as high as 50 per cent. "sideworm injury." On the other hand, orchards in districts that had been well sprayed for several years suffered little injury, thus showing the cumulative effects of good spraying.

Cigar Case-bearer (*Coleophora fletcherella*). This species is usually of comparatively small importance, even in unsprayed orchards, but this year it was present in very large numbers and made the foliage of unsprayed trees very tattered and unsightly.

Bud Moth (*Eucosma ocellana*). This species was somewhat more abundant than usual, especially in Norfolk County.

Pear Leaf Blister Mite (*Eriophyes pyri*). This well-known pest has for several years been held in check by unknown natural factors, but during the past two years it has increased to a very marked extent in many orchards which have not been receiving the so-called dormant application of lime-sulphur. The present indications are that the blister mite will again have to be reckoned with as a first-class orchard pest.

The Mullein Leaf Bug (*Campyloma verbasci*). A small mirid,* which occurs throughout the Province on mullein, catnip, potatoes and several other plants, was found attacking apples this year in two orchards in Norfolk County. Baldwin, Roxbury Russet and Spy were freely attacked and on a few of the infested trees 75 per cent or more of the apples were more or less injured by the bugs feeding on them. It was not uncommon to see one to seven of the little green nymphs on a single apple.

Fig. 2.—Mullein Leaf Bug injury on mature apples.

Conspicuous brown or sometimes blackish corky warts formed at the spots where the punctures were made. In most cases there was only one or two such scars to an apple; in others a ring of them almost encircled the apple; and in others several, close together on the one side, caused the fruit to be lopsided.

All the puncturing was done by the nymphs while the apples were still small —not more than one-half to two-thirds of an inch in diameter. (According to our observations, the adults do not attack the fruit but they do feed very freely upon the leaves and wood of the new growth, and are specially fond of the water-sprouts.)

The nymphs are light green in color and are very small, being, even in the last instar, only about 2 mm. in length. The adults vary in color from greenish to brown, and average about 3 mm. in length. The life history of this species was not worked out, but from the fact that on June 12th most of the nymphs were in the last instar and a few had transformed into adults it would appear

*Species determined by E. P. Van Duzee.

that these must have hatched from the eggs, at the latest, by the time the blossoms appeared.

At the time of picking it was found that most of the apples had almost completely outgrown the plant-bug injury save for small brown or blackish elevated scars on the surface. Badly punctured apples, however, were greatly deformed by the failure of the injured areas to grow. The percentage of blemished apples could not be determined because the fruit was thinned early in the season and the worst specimens picked off.

The San José Scale (*Aspidiotus perniciosus*) has not yet regained the position it held prior to the winter of 1917-18. Both last year and this year it was difficult to find many badly infested trees. The insect, however, is gradually increasing in its old haunts—neglected orchards.

The Apple Leaf Sewer (*Ancylis nubeculana*) was present in most orchards this autumn in moderate numbers. It is usually a rare insect in Ontario.

Fig. 3.—Apple leaves folded by the Apple Leaf Sewer.

Fig. 4.—Pear Slugs skeletonizing cherry leaf.

Lesser Apple Worm (*Enarmonia prunivora*) was, as last year, very scarce.

Pear Slug (*Eriocampoides limacina*). The outbreak of pear slug was repeated this year on an even larger scale than that of 1918. The foliage of thousands of pear and cherry trees throughout a large part of the Province was destroyed, and in the case of early Richmond cherries much of the fruit was rendered worthless. Just as last year, it was the first brood that did nearly all the damage. In a few localities the second brood larvæ were fairly numerous, but in most places they could scarcely be said to have done any injury worth mentioning. The eggs of the second brood were this year, as last, highly parasitized. A few parasites were reared also from the pupæ.

Rose Chafer (*Macrodactylus subspinosus*). In June hordes of rose chafers appeared in the Simcoe and Fonthill sections and injured apples, grapes and cherries.

Tussock Moth (*Hemerocampa leucostigma*). As forecasted in last year's report, little or no injury was done by this species.

Fall Webworm (*Hyphantria cunea*). The unsightly webs of this species were again very conspicuous throughout the province. However, according to our observations the insect was not so abundant as it was last year.

Plum Curculio (*Conotrachelus nenuphar*). This species was unusually destructive in the Niagara District. It was especially injurious to peaches and was responsible for a large "drop." In a peach orchard at Winona over 50 per cent. of the crop was destroyed by it.

Unspotted Tentiform Leaf Miner (*Ornix geminatella*). This unimportant apple insect was common in some orchards in the Niagara District and Norfolk County.

Fig. 5.—Cherry leaves and fruit injured by the Pear Slug. Note the wizened fruit.

Silver Leaf Mite (*Phyllocoptes schlechtendali*). Practically all the foliage in a block of seedling peaches at the Horticultural Experiment Station, Vineland, was affected with silver leaf. This same disease was quite common in other peach orchards in the Vineland district; and in every case we examined we found it was caused by the mite *Phyllocoptes*. It is of interest to note that according to our observations this mite hibernates under the protection of the bud scales and between the leaf petioles and the base of the bud.

Rose Leaf-hopper (*Empoa rosae*). In late summer and fall myriads of rose leaf-hoppers were present in many apple orchards in the Niagara District and Norfolk County and produced a characteristic mottling of the leaves. In a large infested orchard at Simcoe practically all the foliage became pallid and in

the case of Greening trees the appearance of much of the fruit was spoiled by specks of excrement voided by the hoppers.

On October 17th large numbers of females were observed depositing their eggs on apple—in the bark of the smaller branches and twigs.

Apple Aphids. Exceptionally large numbers of recently hatched nymphs were observed in the spring in most sections of Ontario. Heavy washing rains and insect enemies, however, destroyed such a large percentage of the plant lice that no serious injury was effected.

Pear Thrips (*Taeniothrips inconsequens*). This pest was found only in the orchard in which it was taken last year, and here again it was present in very small numbers.

Fig. 6.—(*a*) A normal peach leaf contrasted with (*b*) a leaf injured by the Silver Leaf Mite.

Fulgorid on Pear (*Ormenis pruinosa*). In a Beamsville pear orchard large numbers of a fulgorid nymph pale green in colour and more or less covered with a white woolly material, were found about mid-July feeding on the water-sprouts. The species was reared and proved to be *Ormenis pruinosa*.

Insects Attacking Grapes and Small Fruits.

Grape Leaf-hopper (*Erythroneura comes*). In view of the abundance of various species of leaf hoppers, notably the rose leaf-hopper (*Empoa rosae*) and the

potato leaf-hopper (*Empoasca mali*) it is of interest to note that the grape leaf-hopper was much less conspicuous than usual in vineyards in the Niaraga District.

Blackberry Leaf-miner (*Metallus bethunei*). This leaf-miner was again very destructive in blackberry plantations in the Burlington and Niagara districts. Egg and larval parasites were much more abundant than last year.

Strawberry Leaf-roller (*Ancylis camptana*). This species was apparently somewhat more general than last year but did comparatively little damage.

Imported Currant Worm (*Pteronus ribesii*). As usual, this sawfly did considerable damage to currants and gooseberries.

Strawberry Root Louse (*Aphis forbesi*). It is worth mentioning that this species, which is so destructive in Illinois and other parts of the United States, was found in small numbers in a strawberry plantation at Bismark.

Imported Currant Borer (*Sesia tipuliformis*). Adults of this species were very abundant about mid-June in some black currant plantations in the Niagara district.

Strawberry Root Borer (*Typophorus canellus*). Adults of this species were common in a strawberry patch at Oakville, but apart from eating out holes in the foliage the insects apparently caused no serious injury.

Raspberry Sawfly (*Monophadnus rubi*). This well-known pest of the raspberry was conspicuous by its absence.

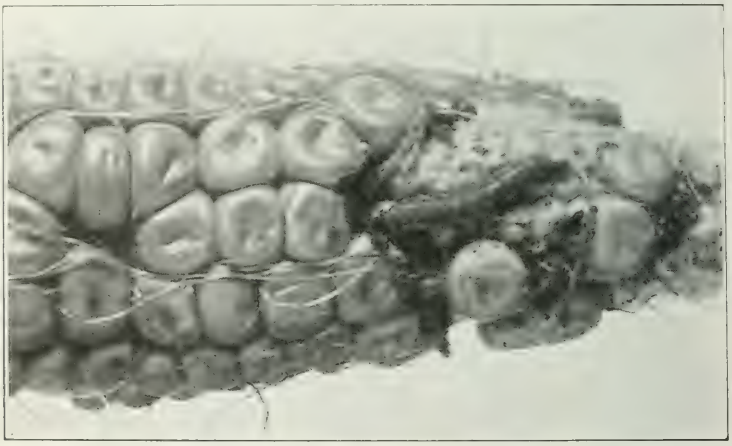


Fig. 7.—Corn Ear Worm and its work.

Insects Attacking Vegetables.

Cabbage Maggot (*Chortophila brassicae*). This insect varied greatly in numbers and destructiveness in the different districts. At Vineland, Burlington, Guelph, London and other parts of southern and western Ontario it did almost no harm except to radishes, but at Ottawa and to a lesser extent in Norfolk County it was abundant and destructive.

Onion Maggot (*Hylemia antiqua*). The onion maggot did much harm at Dixie and in several other localities, but at Burlington and Leamington, as last year, was not of much importance.

Imported Cabbage Worm (*Pieris rapae*). This insect caused much injury in cabbage and cauliflower fields all over the western and southwestern parts of the Province.

Diamond-Back Moth (*Plutella maculipennis*) was very conspicuous in fields of cabbage.

Corn Ear Worm (*Heliothis obsoleta*). This insect attacked the ears of sweet and field corn in many localities this fall. Infested ears were received by the writers from Welland, Lincoln, Wellington and Lambton Counties. Injury was practically confined to late planted corn. In Welland County it was observed that Dent corn was injured more than Flint.

Tomato or Tobacco Worm (*Phlegethontius quinquemaculata*). This species was present in exceptionally large numbers in tomato and tobacco fields in the Leamington district and other parts of western Ontario. It was also common in Norfolk County.

Pea Aphis (*Macrosiphum pisi*). This plant louse was again very destructive to peas grown for the canning factories in Prince Edward County and to a lesser extent in Norfolk County. Field peas were also injured in Lincoln County.

Cutworms. Quite a few complaints were received regarding cutworm injury to cabbage, tomato and corn. What we took to be the dingy cutworm *Feltia ducens* was injurious to cabbage at Vineland about mid-May. The variegated cutworm was moderately abundant throughout the Burlington district and was apparently the cause of most of the holes eaten in tomatoes in September.

Asparagus Beetles (*Crioceris asparagi and C. 12-punctata.*) The two species were very common and injurious in the Niagara district. At Vineland the chalcid parasite (*Tetrastichus asparagi*) was again observed.

Colorado Potato Beetle (*Leptinotarsa decemlineata*). The beetles came through the winter in large numbers and caused much damage early in the year to potatoes and tomatoes. According to reports received, the "Friendly Perillus" was unusually effective as a check.

Cabbage Aphis (*Aphis brassicae*). This louse was very abundant in late summer and fall on cabbage, cauliflower and turnips and caused considerable injury. However, due to the effective work of the parasitic and predaceous enemies, the outbreak did not reach the alarming proportions we anticipated. It is of interest to note that one of the most important insect checks of this species was the larva of *Aphidoletes fulva*.

Red Headed Flea-beetle (*Systena frontalis*). This species was unusually prevalent on beans.

Black Stink-bug (*Cosmopepla bimaculata*) was remarkably abundant this year on grains but so far as we could see caused no injury. Mr. MacLellan, Ontario Vegetable Specialist, reports that during the summer this species killed the tips of asparagus plants in a truck garden at London.

Potato Leaf-hopper (*Empoasca mali*) was remarkably abundant on potatoes and beans throughout the Province. It was generally credited with being responsible for all the leaf burn which was so prevalent on early potatoes. However, we are not at all sure that this claim was wholly correct.

In this connection the following preliminary experiments conducted at the Dominion Entomological Laboratory, Vineland Station, by Mr. Robinson are of interest. Three cheesecloth cages each large enough to cover three plants were put over potatoes growing in the field in June before there were any signs of leaf-burn. Large numbers of leaf-hoppers were introduced into two cages and the third was used as a check. None of the plants were watered. Tip-burn developed on the potatoes in all three cages, and, strange to say, just as rapidly on the check plants as on the infested ones. These experiments were duplicated in the insectary

with potted potato plants which were kept well watered. Here the results were quite different: leaf-burn developed on the infested plants whereas the check (one plant) showed no indications of it at all. The interpretation of these results would appear to be that two factors caused the leaf-burn this year, namely the drought (probably the more important) and the leaf-hopper.

Onion Thrips (*Thrips tabaci*). This pest exacted a very heavy toll this year from the truck gardeners of Ontario. In the counties of Kent and Essex the thrips, aided by the hot, dry weather, reduced the onion crop to one-third of a normal yield.

Tarnished Plant Bug (*Lygus pratensis*). This well known bug was present in exceptionally large numbers this year and caused a considerable amount of damage especially in gardens. Asters and dahlias were attacked so freely that in many sections they were a complete failure. At the Dale Estate, Brampton, only about one thousand flowers were cut from twenty thousand plants. At Kingston spinach grown for seed was injured to such an extent that the plants failed to produce any seed. Plant bug injury, in the form of blasted compound leaves was common in potato fields. The black joint disease of celery caused by the bugs feeding at the joints was prevalent throughout the province. It should be mentioned here that Mr. MacLennan, Ontario Vegetable Specialist, is positive that the tarnished plant bug is the chief agent concerned with the spread of bacterial soft rot or black heart of celery.

Potato Flea-beetle (*Epitrix cucumeris*). In June this species and its work were conspicuous in potato patches in the Niagara district. It was also injurious to tomatoes.

The Three-lined Leaf-beetle (*Lema trilineata*) was unusually common on potatoes in the Niagara peninsula.

The Striped Cucumber Beetle (*Diabrotica vittata*) occurred in more than usual numbers in parts of Norfolk County, but around Burlington and in many other localities it was scarce.

Insects Attacking Field Crops.

Clover Leaf Weevil (*Phytonomus punctatus*). The larvæ of this pest occurred in exceptionally large numbers in parts of the Niagara peninsula and southwestern Ontario. In Norfolk County a whole field of clover was ruined. However, in most fields serious injury was prevented by the almost complete destruction of the grubs by a fungus disease.

Chinch Bug (*Blissus leucopterus*). The chinch bug appeared in large numbers this summer in Gainsboro' Township, Lincoln County, and caused a considerable amount of alarm among the farmers. The centre of infestation was at the village of Bismark and the infested area extended, roughly speaking, about two miles around the village. Meadow grasses, particularly timothy, were in some instances killed outright. Oats were injured to a considerable extent. One six-acre field was completely destroyed and in another field a strip about the width of a drill was also killed outright. However, as a general rule the infested oats did not die but ripened prematurely and produced little or no grain. Some damage was also done to corn.

Late in September we found large numbers of the adults destroyed by the chinch bug fungus (*Sporotrichum globuliferum*). The percentage of mortality varied from 25 per cent. to 75 per cent. in the fields examined.

We hope and expect that the wet weather we have had this fall along with the coming winter will reduce the hibernating adults to insignificant proportions.

Crambid Attacking Wheat (*Crambus caliginosellus*).* In the seven-acre field of wheat in Wainfleet Township, Welland County, over 60 per cent. of the wheat was destroyed by a crambid or sod-worm. Because of the very wet spring this particular field was not worked until August and as a result had been covered with weeds and grasses most of the year. One-half of the field was ploughed about August 1st. This part was not seriously injured. The other half was not ploughed until the middle of August and in this the wheat was so badly damaged that it had to be resown.

Clover Seed Chalcis (*Bruchophagus funebris*). Judging from samples of seed sent in last winter from Kent County, this insect must have been very abundant there in 1918. One correspondent claimed that much of the seed produced in Kent County was destroyed by this tiny insect.

Fig. 8.—Nymphs of Chinch Bug (much enlarged).

Fig. 9.—Showing the long-winged and short-winged forms of the Chinch Bug adult.

Glassy Cutworm (*Sidemia devastatrix*). This cutworm caused some alarm in Middlesex County in mid-June by cutting off wheat plants. The total loss, however, was not great.

Hessian Fly (*Mayetiola destructor*). So far as observed, this insect did not cause any appreciable injury in any district. In several fields approximately 5 per cent. of the plants were attacked.

Miscellaneous.

Warble Flies (*Hypoderma bovis* and *H. lineatum*) threatened to be very numerous judging by the great numbers of warbles seen on the backs of cattle in the spring. Fortunately the danger so far, at least, as the heel fly was concerned did not materialize, and very few complaints of cattle gadding were received.

Spruce Gall Lice (*Chermes abietis* and *C. similis*). Galls caused by these insects were somewhat more conspicuous than they have been for several years. There are evidently powerful natural factors keeping these insects under control.

Grasshoppers. Few complaints were received regarding grasshoppers or locusts. In the Smithville district, however, these pests were more abundant than they had been for many years. Garden crops, alfalfa and oats were very freely attacked.

Cotton Worm (*Alabama argillacea*). Moths of this species visited many parts of Ontario this autumn and attracted considerable attention.

*Species determined by Dr. McDunnough.

Rose Midge (*Dasyneura rhodophaga*). We regret to report that this destructive midge has made further inroads into Ontario. It is now present in six large greenhouses: three in Toronto, one at Grimsby, one at Port Dover, and in the large Dale Estate at Brampton. In every instance the pest was brought in on rose stock imported from the United States.

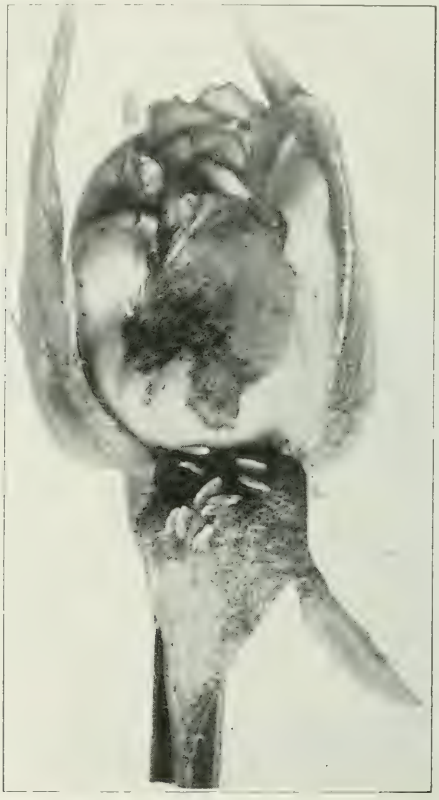


Fig. 10.—Injured rose bud opened to show Rose Midge maggots feeding within. (Enlarged three times.)

Trumpet Vine Midge (*Itonida tecomiae*). During the past two years trumpet vines at Guelph have been seriously injured by a white cecidomyiid larva which curls and distorts the leaves. Badly infested leaves turn brown and die and in this way much of the young growth may be destroyed. We reared the adult and the species was determined by Dr. E. P. Felt, as *Itonida tecomiae* Felt.

REMARKS ON THE ANCESTRY OF INSECTS AND THEIR ALLIES.

G. C. Crampton, Massachusetts Agricultural College.

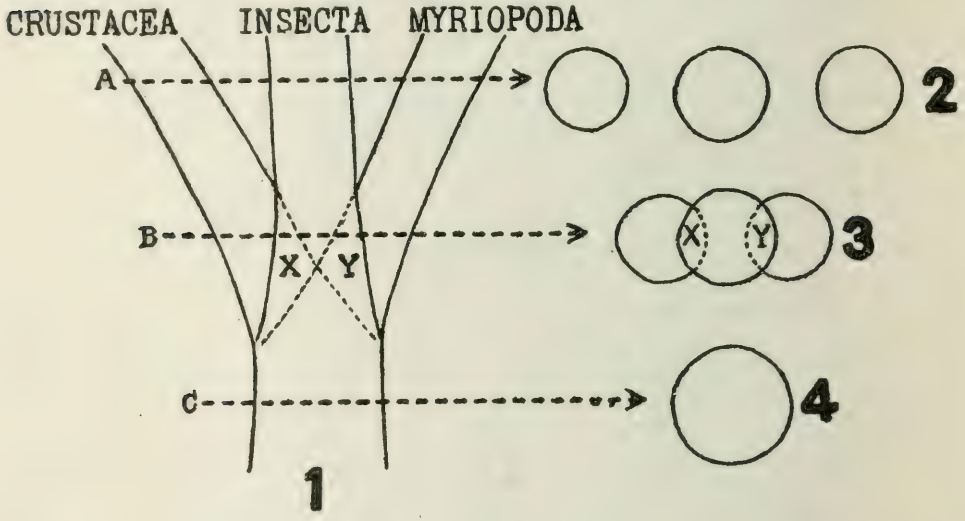
It has been a matter of considerable surprise that so much time and attention have been expended upon the subject of the evolution of mammals, reptiles, and other vertebrates, to the practical exclusion of the consideration of the development of the lines of descent of the insects, Crustacea, "Myriopoda," and other arthropods, especially since the study of the latter forms involves no great outlay in the matter of collecting expeditions, equipment, housing facilities, etc., as is the case with the study of the vertebrate groups. In fact, the arthropods offer unrivaled opportunities for the study of evolution, including, as they do, the greatest number of species of living things, as well as a marvellous range of modifications in adaptation to varied environmental conditions, and a height of development of the psychic faculties (social instincts, etc.) unapproached elsewhere save in the group Mammalia. In addition to these advantages, the ease with which many of them can be obtained, and the fact that no elaborate equipment or technique is necessary for studying their external anatomy brings the group within the reach of practically everyone, and it is most earnestly to be hoped that so fertile a field for research will soon attract a number of investigators commensurate with its great possibilities and its importance from the standpoint of evolution.

Not only has this potentially rich field of research been sadly neglected, but even the meagre investigations which I was able to carry out during the past summer very quickly demonstrated that the prevalent conceptions concerning the meaning of the parts in insects (as interpreted from the standpoint of a comparison with the structures of Crustacea and other arthropods) are in many cases wholly erroneous. Thus the oft repeated statement that the "superlinguae" or "paraglossae" on either side of the hypopharynx of insects represent the first maxillae or "maxillulae" of insects is quite wrong, since the structures in question clearly correspond to the so-called paragnaths or structures on either side of the median ridge (corresponding to the hypopharynx or tongue of insects) in the mouth region of certain Crustacea—and the "superlinguae" or "paraglossae" therefore cannot be regarded as the appendages of a distinct "superlingual" segment in insects, as Folsom has claimed is the case in these forms. The investigations of all embryologists other than Folsom have clearly shown that the "superlinguae" are not appendages of a distinct segment; but practically all recent entomologists have been led astray in a matter which could easily have been righted had they but taken the trouble to examine the corresponding parts in the lower insects and Crustacea. Furthermore, a study of the Crustacea clearly demonstrates that the first maxillae of insects correspond to the first maxillae of Crustacea, while the second maxillae of insects (i.e. the halves of the labium) correspond to the second maxillae of Crustacea, and the head of an insect is therefore comprised of but six (not seven) segments, as embryology has long indicated to be the case.

The statement that the parts of an insect's mandible are comparable to the parts of the maxillae, which has received universal acceptance in the textbooks dealing with the subject, is at once seen to be impossible when one compares a series of crustacean mandibles with those of insects, since such a comparison very clearly shows that the insect's mandible represents the *basal segment alone* of the corresponding appendage in the Crustacea, while the maxillary galea and lacinia

represent processes of *two* distinct basal segments of an appendage, whose terminal portion forms the palpus of the maxilla. Furthermore, a comparison with the parts of the Crustacea very clearly shows that the universally accepted opinion that an insect's maxilla represents a "biramous" appendage is wholly false (the galea and lacinia being merely processes of two basal segments of an appendage whose endopodite alone forms the maxillary palpus), and the attempt on the part of several investigators to compare parts of an insect's mandible (as well as the parts of the maxillae) to the endopodite and exopodite of a crustacean appendage would never have been made if they had but taken the trouble to compare a series of crustacean mandibles with those of insects.

Since the second maxillae of Crustacea are homologous with the second maxillae of insects, which unite to form the labium in the latter forms, it is impossible to homologize the united poison claws of chilopods (which represent the first maxillipedes of Crustacea, and therefore occur behind the second maxillae)

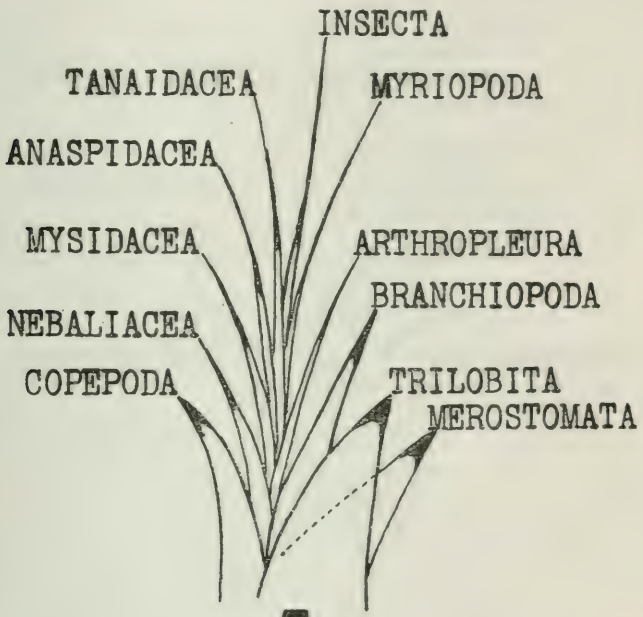


with the second maxillae or labium of insects, as many investigators have sought to do, and the erroneous claim that the underlip (united first maxillae) of diplopods is formed by the fusion of two pairs of appendages, is seen to be untenable when one compares the structures in question with the underlip of certain isopods (which here, however, is formed by the united first maxillipedes) in which the corresponding parts are clearly seen to belong to but *one* pair of appendages, as embryology has shown to be the case all along, although most anatomists have totally disregarded its evidence.

From a comparison with the parts in the Tanaidacea and other Crustacea the cerci of insects are seen to represent one of the rami of the uropods on either side of the telson, and the meaning of the styli attached to the basal segments of the abdominal limbs of the Machilidae and other primitive insects is at once apparent when one examines the reduced abdominal appendages of the Isopoda and other Crustacea. Indeed, the study of the parts in the Crustacea has furnished the key for the interpretation of the corresponding parts in insects in practically every instance, as I am hoping to show in a series of articles soon to be published upon the subject, and these facts are referred to at this point merely to show that

a study of this most promising field has been grossly neglected, and even the few observations which have been made are for the most part badly in need of revision!

Despite Handlirsch's claim to the contrary (and his opinion has gained a surprisingly wide acceptance among recent writers), a comparison with the Crustacea and "Myriopoda" should convince anyone that the Apterygota rather than the winged insects, are the most primitive representatives of the class Insecta, and by no possible stretch of the imagination can the Apterygota be regarded as degenerate winged forms, as Handlirsch would have us believe! Instead of upholding Handlirsch's fantastic view that winged insects can be directly derived from Trilobites without the intervention of apterygotan forms, and a long series of intermediate stages, a comparison of the parts in insects, "Myriopoda,"

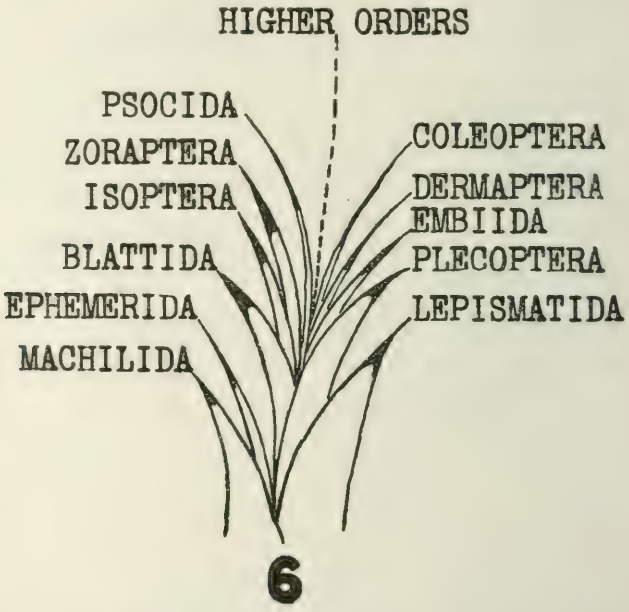


5

Crustacea, Trilobita, and the Merostomata, would clearly indicate that between the type of mouthparts, head capsule, and other structures found in the Trilobita, and those of even the most primitive representatives of the group Insecta, there must have occurred a long series of intermediate stages leading through the lower Crustacea, the lower Malacostraca, and the ancestors of the higher Crustacea (i.e. Isopoda, Tanaidacea, etc.) before the insectan types of structures were developed: and one cannot help but suspect that Handlirsch and his followers are either wholly ignorant of the absolutely obvious and patent evidence afforded by a study of the parts in the Crustacea and their allies, or they have deliberately ignored the tremendous array of facts whose evidence should have convinced them of the error of their contentions.

It is the fashion nowadays to consider the "Myriopoda" as the nearest representatives of the common ancestors of pterygotan and apterygotan insects: but here again, a comparative study of the structures in the Crustacea and certain of the Apterygota such as *Machilis* and *Lepisma* should have been made before

such a view was promulgated, for such a study clearly indicates that the lines of development lead from the common ancestors of the isopods, Tanaidacea, Cumacea, and other Crustacea, through those of the Machilidae and Lepismatidae to the ancestors of the most primitive representatives of the winged insects such as the mayflies (Ephemerida) and stoneflies (Plecoptera). The structural resemblance between the mayflies and the Machilidae, or that between the Plecoptera and the Lepismatidae, is most striking, and the lines of descent of the Machilidae and Lepismatidae clearly lead back to Crustacea-like, rather than to "Myriopod"-like ancestors. It must be admitted, however, that certain other apterygotan insects such as the Campodeidae, Protura, etc., are extremely closely related to certain "Myriopoda" such as *Scolopendrella, Pauropus,* etc., but the lines of descent of these forms appear to represent merely side issues of the main trunk which leads to the evolution of the pterygotan insects (unless such insects as



Campodea, Japyx, and other insects of the apterygotan order Rhabdura, are near the forms giving rise to the line of development of the pterygotan order Dermaptera, as I formerly held to be the case—but a further study of the insects in question has tended to discredit this view).

Although the main lines of descent of the pterygotan insects appear to avoid the "myriopodan" side of the ancestry of insects and to lead back more directly to Crustacea-like forms through ancestors resembling the Machilidae and Lepismatidae, the dual relationship of apterygotan insects to the "Myriopoda" as well as to the Crustacea, cannot be ignored. This dual relationship is expressed graphically in Fig. 1. As is shown in the figure, the lines of descent of the "Myriopoda," Insecta, and higher Crustacea (Isopoda, Tanaidacea, Cumacea, etc.) taken at the level "A" are quite distinct (as is represented by cross sections of these lines of descent shown in Fig. 2); but at the level "B," where the lines of descent begin to converge as they approach their common source, it is evident that the members of the three groups come very close together, and those insects occupying the

"hereditary area" labeled "X" in Fig. 1, would naturally be expected to resemble the Crustacea quite closely, since the territory which they occupy is contiguous to that of the higher Crustacea. Similarly, those insects which occupy the "hereditary area" labeled "Y," would greatly resemble the "Myriopoda," since the territory which they occupy is contiguous to that of the "Myriopoda." Cross sections of the three lines of descent at the level "B" would be represented as three intersecting circles (Fig. 3), each of which, taken separately, demarks a distinct group (Crustacea, Insecta and Myriopoda); but the intersecting circles have a certain amount of territory in common, and those insects in the area labeled "X" (Fig. 3) being next to the Crustacea, would naturally have much in common with the Crustacea (left hand circle), while those insects in the area labeled "Y" being next to the "Myriopoda" (right hand circle) would naturally have much in common with the "Myriopoda." If we trace the lines of descent back to the level "C" (Fig. 1) they are seen to merge in a common "crustaceoid" ancestry; and a cross section at this level would represent the circles as completely coinciding (Fig. 4). It is thus readily comprehensible that there may be a dual relationship between the Insecta and higher Crustacea, on the one hand, and between the Insecta and the "Myriopoda" on the other—as we are forced to conclude is the case, from a study of the anatomy and embryology of the forms in question. This may indicate that the group Insecta is a polyphyletic one, and although I have been loath to accept this view, I can see no escape from the conclusion that insects are very closely related to both the higher Crustacea (Isopoda, Tanaidacea, Cumacea, etc.) and the "Myriopoda."

Since it is quite evident that the lines of descent of the higher Crustacea, Insecta, and "Myriopoda" soon merge in a common ancestry, the question naturally arises as to what these common ancestors were like. That these common ancestors were all of one type is out of the question, for they apparently differed among themselves as much as the Mysidacea, Anaspidacea and other "intermediate Malacostraca" (possibly including Arthropleura also) differ among themselves; and these common ancestors probably resembled all of the forms just mentioned (i.e. the Mysidacea, Anaspidacea, etc.), though it is possible that the Cumacea and Tanaidacea are more like the *immediate* ancestors of insects than are the Mysidacea, Anaspidacea, etc., which are more like their *remote* ancestors.

The Anaspidacea, Mysidacea, and other "intermediate Malacostraca" are in turn derived from ancestors resembling the Nabaliacea and other primitive Malacostraca, and the lines of development of the malacostracan Crustacea have undoubtedly accompanied those of the insects and "myriopods" more closely and for a longer distance than any other forms have done. The primitive malacostracan Crustacea such as *Nebalia* and its allies, exhibit undoubted affinities with the Branchiopoda and Copepoda, and to some extent with the Trilobita also, and they have even preserved some ancestral features in common with the Merostomata, although the latter forms lead off toward the lines of development of the Arachnoidea, and away from the lines of development of the higher Crustacea, Insecta, and "Myriopoda."

The question as to which arthropods have departed the least from the common ancestors of the phylum Arthropoda is an extremely difficult one to answer. The Copepoda, Branchiopoda and Trilobita are among the most primitive known arthropods, and it is quite probable that the first representatives of the group combined in themselves characters common to all three. Thus, for example, the earliest arthropods were in all probability not trilobites alone, but were doubtless

trilobite-branchiopods, trilobite-copepods, etc., having many features in common with all three of these primitive groups, though in many respects the Trilobita have departed as little as any known forms from the ancestral type. It is thus necessary to make composites combining the primitive characters occurring in all of these primitive groups in order to come to the correct conclusion concerning the character of the ancestral arthropods. The Merostomata have also retained many features which must have been present in the ancestral arthropods; but their lines of descent (which apparently sprang from ancestors resembling the Trilobita) lead off toward the arachnoids, which lie in a side line having no direct bearing on the origin of the insectan and myriopodan type of arthropod. The ancestors of the arthropods themselves were in all probability very much like annelid worms, though other forms such as the Onychophora, etc., have retained many features characteristic of the ancestors of the phylum Arthropoda; but a discussion of these forms has no particular bearing upon the question of the nature of the more immediate ancestors of the higher Crustacea, Insecta, and "Myriopoda," and they need not be further considered here. It may be of some interest, however, to indicate briefly the principle lines of descent of the more primitive representatives of the class Insecta, and I have therefore included a diagram giving the lines of descent of those forms which have departed the least from the types ancestral to the higher groups of insects, although, as is also the case with the diagram of the lines of descent of the arthropodan allies of insects, it has been necessary to omit many important groups in order not to make the diagrams too cumbersome and intricate for practical purposes.

LATER DEVELOPMENTS IN THE EUROPEAN CORN BORER SITUATION.

E. P. Felt, State Entomologist of New York.

The last two months have witnessed a considerable extension of infested territory, the most significant being the area in Erie and Chautauqua Counties, New York, some twenty-five miles long, extending from Angola to Fredonia and with a known maximum width of ten miles. There is in addition a small infestation at North Girard, Erie County, Pennsylvania, and the probabilities are that the New York and Pennsylvania areas may be connected by a sparse infestation. In fact, the early corn planted on the light soil south of the lake is a suspicious area and it is impossible at the present time to define closely the extent of the infested territory in this section.

Explorations in the vicinity of the Schenectady area tend to confirm in a general way at least the limits established during the summer. The infestation in Massachusetts and New Hampshire has already been described in detail and requires no further comment at the present time.

A most significant development has been the failure of the European corn borer to produce two broods in the infested area in New York State. This means a very material reduction in the possibilities of injury and it is gratifying to state that in the earlier discovered Schenectady area, a section thoroughly cleaned up last spring, the maximum injury has hardly overrun one per cent. in a few very restricted areas, possibly amounting to five per cent. It is considered advisable for the present to content ourselves with the statement that but one generation

developed last year since there is a possibility, perhaps very remote, that two generations may occur in this area during certain seasons and this condition may, after all, prove to be the normal.

The decidedly disturbing feature is the very sparse, inconspicuous character of the infestation in the western part of the state, a section where the insect has bred in a few localities at least for two seasons. The infestation was brought to the attention of Cornell University authorities through the accidental discovery of a few borers in a stalk, although a farmer in that vicinity had noted the injury the preceding season but had failed to appreciate its significance. In most of the territory, however, a very close examination is necessary to find the borer and these conditions suggest the comparative inefficiency of publicity measures and the great difficulty of organizing a sufficiently thorough scout of the corn fields of America to determine with a reasonable degree of accuracy the limits of the present infested areas.

We have yet to find unquestioned evidence as to the agencies producing these isolated infestations. It looks very much as though railway lines were an important factor, possibly in carrying the moths, since both the eastern and western areas in New York State have good railway connections with the older infested area in Massachusetts.

The occurrence of but one brood in the cooler corn-producing areas of New York State, even if this be normal, cannot be construed as being true of our great southern and warmer corn belt. The sparsely infested areas must be regarded as a real menace to much of the corn crop of America. The most practical method of handling the situation appears to be pushing the publicity campaign as far as practical, systematic scouting of the more suspicious areas so far as they can be determined and a comprehensive campaign of control designed specially to check spread until the economic status of the borer can be determined in this country.

THE ENTOMOLOGICAL RECORD, 1919.

Arthur Gibson and Norman Criddle, Entomological Branch, Dominion Department of Agriculture.

The collecting season of 1919 does not appear to have provided any marked variation from the preceding year. In the Middle West a continuation of the drought in southern sections was especially favourable to the development of dry-loving insects, more notably Orthoptera, which in some parts increased to injurious numbers. Somewhat similar conditions prevailed in British Columbia and probably to a lesser extent in Ontario. Collecting, generally, was reported to have been good during the first part of the season but later became less so. It is gratifying to report that more attention is being devoted to hitherto neglected orders; as a result a far broader knowledge of the distribution of Canadian insects is being obtained.

During 1919, students of insects in Canada, have, as in previous years, been much assisted in their studies by various specialists, particularly those resident in the United States. To all who have assisted us, we extend our grateful thanks.

Literature.

Among the publications which have appeared during 1919, the following are of interest to Canadian students.

Bowman, Kenneth. Annotated Check List of the Macrolepidoptera of Alberta. Published by the Alberta Natural History Society, Red Deer, Alta., 16 pp., February, 1919. In the preparation of this list the author has "endeavoured to provide an epitome of what has been accomplished by students of this order within the province to date, as an aid, not only to present workers but those who will follow after." We were very glad indeed to receive this list. It is a very useful contribution.

Canadian Arctic Expedition (1913-1918) Insect Reports. These reports on the insects of the various orders collected by members of the expedition were published in 1919, with the exception of the one on the Lepidoptera which was issued early in January, 1920. They comprise Vol. III of the Report of the Canadian Arctic Expedition. Ottawa: J. de Labroquerie Tache, Printer to the King's Most Excellent Majesty.

Part A: Collembola, by Justus W. Folsom, 29 pp., 8 plates. Twelve species are discussed, three of which are described as new. The plates illustrate structural characters.

Part B: Neuropteroid Insects, by Nathan Banks, 5 pages, 1 plate. Five species are definitely determined, two of which are described as new. Two additional generic determinations are given. The plate illustrates genitalia of the two new species and views of other male characters.

Part C: Diptera, 90 pp. Crane flies, by C. P. Alexander; Mosquitoes by H. G. Dyar, and other Diptera by J. R. Malloch. In the first portion on the Tipulidae, sixteen species are reported upon. Of these, thirteen are new. The six plates accompanying the section, illustrate wings, antennae and other structures. The mosquitoes represented three species one of which only is definitely determined and this is described as new. The third section reporting upon other Diptera collected, comprises pages 34 to 90, (10 plates). The number of species listed is ninety-three,

representing fifty-five genera. Thirty-two new species are described and one new variety. The plates show various structural characters.

Part D: Mallophaga, 12 pp., by A. W. Baker; Anoplura, by G. F. Ferris and G. H. F. Nuttall. Sixteen species are recognized in the former paper. One plate illustrates four species. In the latter contribution three species are listed.

Part E: Coleoptera, 27 pp. Forest Insects, including Ipidae, Cerambycidae and Buprestidae, by J. M. Swaine; Carabidae and Silphidae, by H. C. Fall; Coccinellidae, Elateridae, Chrysomelidae and Rhynchophora (excluding Ipidae), by C. W. Leng; Dytiscidae, by J. D. Sherman, Jr. In this part sixty species are determined, four of which are described as new. Three plates showing ipid beetles and their work, illustrate Dr. Swaine's section.

Part F: Hemiptera, 5 pp., by Edward P. Van Duzee. Six species are definitely recognized, one of which is described as new. Generic determinations of five other species are given.

Part G: Hymenoptera and Plant Galls, 38 pp. Sawflies—Tenthredinoidea, by Alex. D. MacGillivray; Parasitic Hymenoptera, Chas. T. Brues; Wasps and Bees, F. W. L. Sladen; Plant Galls, E. P. Felt. In this part, records of thirty-five species are included; others have been determined generically. Of the thirty-five species, twenty-one, mostly sawflies, are described as new. Two plates illustrate the eighth ventral segment in the males of four species of *Bombus*.

Part H: Spiders, by J. H. Emerton; Acarina, by N. Banks; Chilopoda, by Ralph V. Chamberlin; 22 pp. Twelve species of spiders are recorded, three of which are described as new. Two plates show structural characters. The Acarina collected include seventeen species, all but one previously known. Only two species of Chilopods were represented in the material secured by the expedition. A new species of *Ethpolys* from Washington and Oregon States, as well as a sub-species of this new species, the former from Alaska, are also described by Mr. Chamberlin.

Part I: Lepidoptera, by Arthur Gibson, 58 pp., 6 plates. In this report is also included notes on other species collected in Arctic America, not met with by members of the expedition, all of which material is in the National Collection of Insects at Ottawa. Altogether notes and records of ninety-seven species are included, nine of which are described as new species. In addition, two new varieties are recognized. Plate i shows genitalia of species of Oeneis; ii, under-sides of nine examples and underside of one, of species of the same genus. Plates iii, iv and v, the latter two coloured, illustrate a number of the rarer and new species collected by the expedition, of the genera *Pieris, Erebia, Brenthis, Eurymus, Oeneis,* etc.

Emerton, J. H. Catalogue of the Spiders of Canada, known to the year 1919. Trans. Royal Canadian Institute, Toronto, 1919. This catalogue which contains the names of 342 species of spiders which have been found in Canada will be of considerable interest and value to those persons who are collecting these creatures in Canada.

Fall, H.C. The North American Species of Coelambus. Published by John D. Sherman, Jr., 1919. This pamphlet of 20 pp. includes several Canadian records. Twelve new species are described, three of which are from Western Canada.

Hart, Charles Arthur. The Pentatomoidea of Illinois with keys to the Nearctic Genera. Division of Natural History Survey, Vol. XIII, Article VII, pp. 157-223. This contribution will undoubtedly be of value to our students of Hemiptera. Keys to families, sub-families, tribes, genera and species are given. Notes and distribution records are included of each species. Five plates illustrate structural differences, and one plate shows typical Pentatomoidea.

Lochhead, Wm. Class Book of Economic Entomology, with special reference to the economic insects of the Northern United States and Canada. Philadelphia: P. Blakeston's Son & Co., 436 pp., 257 illustrations, price $2.50. This volume is a companion to Reese's book on Economic Zoology. It is divided into four parts: Part I discusses the structure, growth and economics of insects; Part II the identification of insects injurious to farm, garden and orchard crops, etc.; Part III the classification and description of common insects; Part IV the control of injurious insects. This new volume will certainly find a useful place among economic workers.

Washburn, F. L. Injurious Insects and Useful Birds. J. B. Lippincott Company, Philadelphia; 414 illustrations in text and four coloured plates. A useful work of reference, the result of 21 years of work in entomology on the part of the author. Chapters I to VI deal with the losses to agriculture due to insects and rodents, etc.; Chapters VII to XVIII discuss insects affecting the various crops; chapter XIX, "Our Insect Friends"; XX, "The Relation of Birds to Agriculture" and XXI, "Some Four-footed Pests of the Farm," completes the volume.

NOTES OF CAPTURES.

Species preceded by an asterisk (*) described during 1919.

Lepidoptera.

(Arranged according to Barnes and McDunnough's Check List of the Lepidoptera of North America).

Pieridæ.

33. *Pieris occidentalis* calyce Edw. Edmonton, Alta.; Pocahontas, Alta.; April (K. Bowman). Addition to the Alberta list.

57. *Eurymus hecla glacialis* McLach. Nordegg, Alta.; June, (K. Bowman). Addition to the Alberta list.

59. *Eurymus eriphyle autumnalis* Ckll. Edmonton, Alta.; Banff, Alta.; Nordegg, Alta.; Red Deer, Alta.; (K. Bowman). Addition to Alberta list.

64. *Eurymus christina pallida* Ckll. Nordegg, Alta.; Red Deer, Alta.; (K. Bowman). Addition to Alberta list.

64. *Eurymus christina gigantea* Stkr. Edmonton, Alta.; Nordegg, Alta.; Red Deer, Alta.; (K. Bowman). Addition to Alberta list.

Satyridæ.

* *Oeneis semidea arctica* Gibson. Bernard Harbour, N.W.T., July, 1916, (F. Johansen); Rep. Can. Arctic Exp., 1913-18; Vol. III, Part I, Lepidoptera, p. 13.

* *Oeneis simulans* Gibson. Bernard Harbour, N.W.T., July, 1915, (F. Johansen); Rep. Can. Arctic Exp. 1913-18; Vol. III, Part I, Lepidoptera, p. 14.

* *Oeneis cairnesi* Gibson. White River District, Y.T., lat. 61° 55′, long. 141°, July 16, 1913, (D. D. Cairnes); Rep. Can. Arctic Exp. 1913-18, Vol. III, Part I, Lepidoptera, p. 15.

* *Oeneis brucei yukonensis* Gibson. Klutlan Glacier, Y.T., June 13-15, 1913, (E. W. Nesham); elevations 8,200-8,500 feet; Rep. Can. Arctic Exp. 1913-18, Vol. III, part I, Lepidoptera, p. 15.

Nymphalidæ.

151. *Euptoieta claudia* Cram. Fort Steele, B.C., (W. B. Anderson). First record we have for British Columbia.

157. *Argynnis leto* Behr. Blairmore, Alta., July, (K. Bowman). Addition to Alberta list.

* *Brenthis natazhati* Gibson. 141st Meridian, north of Mount Natazhat, 8,600 feet, June 15, 1913, (E. W. Nesham); Bernard Harbour, N.W.T., July 14, 1916, (F. Johansen); Rep. Can. Arctic Exp. 1913-18, Vol. III, Part I, Lepidoptera, p. 21.

* *Brenthis distincta* Gibson. Harrington Creek, Y.T., lat. 65° 05', July 30, 1912, (D. D. Cairnes); Eduni Mt., 6,000 ft., Gravel River, N.W.T., July 8, 1908, (J. Keele); Tindir Creek, Yukon Territory, lat. 65° 20' international boundary; July 25, 1912, (D. D. Cairnes); Rep. Can. Arctic Exp. 1913-18, Vol. III, Part I, Lepidoptera, p. 25.

211. *Euphydryas nubigena beani* Skin. Pocahontas, Alta., July, (K. Bowman). Addition to Alberta list.

283. *Vanessa virginiensis* Dru. Edmonton, Alta., July, (D. Mackie). Addition to Alberta list.

Lycaenidæ.

352. *Strymon melinus* Hbn. Onah, Man., Aug. 20, 1914, (E. Criddle).

* *Plebeius incariodes blackmorei* B. & McD. Goldstream, V. I., B.C., May 31, (E. H. Blackmore); Can. Ent. LI, 92.

427. *Plebeius melissa* Edw. In the note regarding this species published in the *Ent. Record* for 1918, the word "common" should be corrected to read "uncommon."

Sphingidæ.

753. *Proserpinus flavofasciata* Wlk. Mile 214, H. B. Ry., Man., July 17, (J. B. Wallis).

Saturniidæ.

794. *Pseudohazis eglanterina* Bdv. Blairmore, Alta., (K. Bowman). Addition to Alberta list.

Arctiidæ.

851. *Roeselia minuscula* Zell. Miami Man., July 4, 1914, (J. B. Wallis).

Noctuidæ.

1076 *Melaporphyria immortua* Grt. Edmonton, Alta., May, (K. Bowman). Addition to Alberta list.

* *Parabarrovia keelei* Gibson. Mountain below Twitza River, near Gravel River, N.W.T., July 2, 1908, (J. Keele); Rep Can. Arctic Exp. 1913-18, Vol. III, Part I, Lepidoptera, p. 33.

1275 *Euxoa infracta* Morr. Blairmore, Alta., Aug., (K. Bowman). Addition to Alberta list.

1332. *Euxoa esta* Sm. Wellington, B.C., Aug., 19, 1903, (T. Bryant); Victoria, B.C., Sept. 3, 1916, (E. H. Blackmore). Listed in 1906 B.C. list under the name *velleripennis*, (E.H.B.).

1339. *Euxoa campestris* Grt. Edmonton, Alta., August, (D. Mackie). Addition to Alberta list.

1379. *Chorizagrotis thanatologia perfida* Dod. Peachland, B.C., July 30, 1919, (J. B. Wallis).

1455. *Agrotis cinericollis* Grt. Lillooet, B.C., July 3, 1918, (A. W. A. Phair). Peachland, B.C., Aug. 8, 1915, (J. B. Wallis). New to British Columbia, (J. B. Wallis).

1507. *Aplectoides occidens* Hamps. Sicamous, B.C., Aug. 12, 1915, (J. B. Wallis).

1596. *Rhynchagrotis gilvipennis* Grt. Maillardville, B.C., July 18, 1919, (L. E. Marmont).

* *Anarta subfumosa* Gibson. Armstrong Point, Victoria Island, N.W.T., July, 1916, (J. Hadley); Rep. Can. Arctic Exp. 1913-18, Vol. III, Part I, Lepidoptera, p. 34.

1871. *Stretchia plusiæformis* Hy. Edw. Among some specimens determined for Canon V. A. Huard, of Quebec, Que., was one of this species, which was described from Nevada. As I had never seen this species from Eastern Canada, I questioned its occurrence in Quebec Province, but Canon Huard assured me that it was captured at Chicoutimi in 1881. (A.G.).

1900. *Perigrapha algula* Sm. Sahtlam, Van. Isl., B.C., May 10, 1918, (G. O. Day).

1986. *Rancora brucei* Sm. Nordegg, Alta., June, (K. Bowman). Addition to Alberta list.

2060. *Oncocnemis umbrifascia* Sm. Lillooet, B.C., Sept. 5, 1918, (A. W. A. Phair). New to British Columbia, (E.H.B).

2137. *Graptolitha ferrealis* Grt. Edmonton, Alta., April (D. Mackie). Addition to Alberta list.

2174. *Xylena thoracica* Put.-Cram. Okanagan Falls, B.C., April 7, 1913, (E. M. Anderson); Rossland, B.C., (W. H. Danby). New to British Columbia. It may be mentioned here that the species going under the name of *cineritia* Grt., in B.C. collections is in reality *mertena* Sm., (E.H.B.).

2178. *Eurotype confragosa* Morr. Tahu River, B.C., Sept. 30, 1906, (T. Bryant). This is the first authentic record for B.C. *Medialis* Grt., which is a synonym of *confragosa* Morr. is recorded from Wellington, B.C., in the 1906 check list but upon a recent examination of the specimen I find it to be *E. contadina* Sm. (E.H.B.).

* *Homoglaea murrayi* Gibson. Bernard Harbour, N.W.T., July 10, 1916. (F. Johansen); Rep. Can. Arctic Exp. 1913-18, Vol. III, Part I, Lepidoptera, p. 36.

2316. *Trachea mixta* Grt. Winnipeg, Man., June 24, 1911, (J. B. Wallis).

2380. *Luperina passer conspicua* Morr. Edmonton, Alta., (D. Mackie). Addition to Alberta list.

2513. *Merolonche ursina* Sm. Nordegg, Alta., June, (K. Bowman). Addition to Alberta list. Wellington, B.C., June 6, 1904, (T. Bryant). This name is new to B.C., but I suspect it is the same insect which has been previously recorded under the name *lupini* Grt. Very rare in B.C. collections, (E.H.B).

2636. *Helotropha reniformis atra* Grt. Victoria, B.C., Aug. 2, 1916, (E. H. Blackmore); Duncan, B.C., (E. M. Skinner). First record of the form *atra* from B.C., (E.H.B.).

2837. *Eutricopis nexilis* Morr. Reared from larvæ found on *Antennaria* at Aylmer, Que., emerged in office Jan. 10, 1920, (J. McDunnough).

3012. *Sarrothripus revayana cinereana* N. & D. Vancouver, B. C., May 6, 1902; Mission, B.C., Aug. 8, 1904, (R. V. Harvey). New record for B.C., (E.H.B.).

* *Autographa rectangula nargenta* Ottol. Vancouver Island, (A. W. Hanham); Kalso, B.C., (J. W. Cockle); Jour. N. Y. Ent. Soc., XXVII, 122.

* *Autographa interalia* Ottol. Nordegg, Alta., (K. Bowman); Banff, Alta., (R. Ottolengui); Jour. N. Y. Ent. Soc., XXVII, 122.

* *Autographa diversigna* Ottol. Nordegg, Alta., (K. Bowman); Laggan, Alta., (T. Bean); Jour. N.Y. Ent. Soc. XXVII, 121.

* *Autographa magnifica* Ottol. Ucluelet, B.C., (C. H. Young); Jour. N.Y. Ent. Soc. XXVII, 124.

3241. *Autographa ottolenguii* Dyar. Dawson, Y.T., 1909, (A. Day).

Autographa pulchrina Haw. Dawson, Y.T., 1909, (A. Day). This record was received from Mr. G. O. Day, of Duncan, B.C., with the statement "Dr. Ottolengui gave me to understand that this is the first record for the North American Continent."

3313. *Melipotis versabilis* Harv. Quamichan, Van. Isl., B.C., May 31, 1908, (G. O. Day); Cawston, B.C., July 24, 1917, (W. R. S. Metcalfe).

3333. *Syneda alleni saxea* Hy. Edw. Blairmore, Alta., June, (K. Bowman). Addition to Alberta list.

3487. *Epizeuxis scobialis* Grt. Kingsmere, Que., July 23, 1919, (R. N. Chrystal).

3501. *Zanclognatha minoralis* Sm. Quebec, Que., July 27, 1918, (V. A. Huard). Addition to Quebec list.

Notodontidæ.

3640. *Heterocampa umbrata* Wlk. Aylmer, Que., June 2, 1919, (C. B. Hutchings). Addition to Quebec list.

Lymantriidæ.

* *Olene dorsipennata* B. & McD. Chelsea, Que., July 8-14; Aylmer, Que., (J. McDunnough); Can. Ent. LI, 102.

3712. *Olene vagans willingi* B. & McD. Edmonton, Alta., July, (D. Mackie). Addition to Alberta list.

3712. *Olene vagans grisea* B. & McD. Quamichan, Vancouver Island, B.C., July 22, 1916, (G. O. Day).

Geometridæ.

3972. *Coryphista meadi* Pack. Blairmore, Alta., June-July, (K. Bowman). Addition to Alberta list.

3990. *Thera otisi* Dyar. Mt. Arrowsmith, Vancouver Island, B.C., (T. Bryant).

3999. *Dysstroma cervinifascia* Wlk. Nordegg, Alta., July, (K. Bowman). Addition to Alberta list.

4017. *Hydriomena renunciata* Wlk. "Province of Quebec" (V. A. Huard). Addition to Quebec list. Edmonton, Alta., May-June, (K. Bowman). Addition to Alberta list.

4208. *Eupithecia albicapitata* Pack. Edmonton, Alta., July, (K. Bowman). Addition to Alberta list.

* *Eupithecia probata* S. & C. Duncan, B.C., (C. Livingstone); Victoria, B.C., March 30, 1916; April 3, 1916, (E. H. Blackmore); Lepidopterist iii, 105.

* *Eupithecia moirata* S. & C. Penticton, B.C., April, 1913, (E. H. Blackmore); Lepidopterist, iii, 107.

4325. *Drepanulatrix liberaria* Wlk. Aylmer, Que., Sept. 3, 1919, (C. B. Hutchings).

4332. *Philobia ulsterata* Pears. Edmonton, Alta., June, (K. Bowman). Addition to Alberta list.

4349. *Macaria purcellata* Tayl. Nordegg, Alta., July, (K. Bowman). Addition to Alberta list.

4465. *Caripeta divisata* Wlk. Edmonton, Alta., July, (K. Bowman). Addition to Alberta list.

4489. *Pygmæna simplex* Dyar. Nordegg, Alta., July, (K. Bowman). Addition to Alberta list.

Pyralidæ.

4974. *Diaphania nitidalis* Stoll. Meach Lake, Que., Sept. 16, 1903, (C. H. Young). Addition to Quebec list.

5032. *Loxostege commixtalis* Wlk. Banff, Alta.; Nordegg, Alta., June-July, (K. Bowman). Addition to Alberta list.

* *Diasemia alaskalis* Gibson. Collinson Point, Alaska, July 10, 1914, (F. Johansen); W. of Konganevik (Camden Bay) Alaska, July, 1914, (F. Johansen); Rep. Can. Arctic Exp., Vol. III, Part I, Lepidoptera, p. 45.

5051. *Diasemia plumbosignalis* Fern. Nordegg, Alta., July, (K. Bowman). Addition to Alberta list.

5088. *Phlyctænia ferrugalis* Hbn. Edmonton, Alta., June, (K. Bowman). Addition to Alberta list.

* *Pyrausta ainsliei* Heinrich. St. John's, Que., (W. Chagnon). Jour. Agr. Research, XVIII, 3, 175.

5135. *Pyrausta fumoferalis* Hlst. Edmonton, Alta., June, (K. Bowman). Addition to Alberta list.

5548. *Mineola tricolorella* Grt. Reared from larvæ found in apples in Okanagan Valley, B.C., (E. P. Venables).

* *Pyla arctiella* Gibson. Collinson Point, Alaska, July 17, 1914, (F. Johansen); Rep. Can. Arctic Exp., 1913-18, Vol. III, Part I, Lepidoptera, p. 46.

Pterophoridæ.

5915. *Pterophorus sulphureodactylus* Pack. Pointe Aux Alouelles, Ste. Catherine Bay, opp. Tadousac, Que., July 28, 1919, (V. A. Huard). Addition to Quebec list.

Gelechiidæ.

* *Aristotelia fragariæ* Busck. Victoria, B.C., (W. Downes); Proc. Ent. Soc. of Wash., XXI, 52.

6166. *Paralechia pinifoliella* Cham. Ottawa, Ont., July 1, 1907, (C. H. Young).

6200. *Anacampsis tristrigella* Wlshm. Aylmer, Que., June 21, 1919, (J. McDunnough). Addition to Quebec list.

6283. *Gelechia conclusella* Wlk. Ottawa, Ont., June 24, 1906, (C. H. Young).

6288. *Gelechia panella* Busck. Maple Bay, B.C., Aug. 3, 1914, (A. W. Hanham).

6290. *Gelechia fuscotæniaella* Cham. Aweme, Man., Sept. 5, 1915, (N. Criddle).

Tortricidæ.

* *Tortricodes fragariana* Busck. Victoria, B.C., (W. Downes); Proc. Ent. Soc., Wash., XXI, 52.

Gracilariidæ.

7925. *Lithocolletis affinis* F. & B. Aylmer, Que., July 24, 1919; mines in *Lonicera*, (J. McDunnough).

Coleoptera.

(Arranged according to Henshaw's list of Coleoptera of America, North of Mexico.)

Carabidæ.

* *Bembidium lengi* Notman. Cochrane, Ont., Aug., 1918, (Howard Notman); Jour. N.Y. Ent. Soc., XXVII. 98.

* *Pterostichus laevilatus* Notman. Golden, B.C., (Leng. col.); Jour. N.Y. Ent. Soc., XXVII, 231.

680. *Celia gibba* Lec. Aweme, Man., March 29, 1918; Maryfield, Sask., Aug. 30, 1916, (N. Criddle).

Celia brumalis Casey. Aweme, Man., Sept. 2, 1916, (E. Criddle). New to Canada.

* *Asaphidion yukonense* Wickham. Yukon Crossing, Y.T., May 21, 1911, (J. M. Jessup); Proc. Ent. Soc., Wash., XXI, 180.

Dytiscidæ.

1292. *Coelambus suturalis* Lec. Winnipeg, Man., Thornhill, Man., Miami, Man., Mile 214 to 332, H.B.R., Man., (J. B. Wallis). New to Manitoba.

* *Coelambus canadensis* Fall. Winnipeg, Man., Stony Mountain, Man., Miami, Man., (J. B. Wallis); N. A. species of *Coelambus*, published by J. D. Sherman, New York, 1919.

* *Coelambus tumidiventris* Fall. Stony Mountain, Man., April 15, 1912; Winnipeg, Man.; Stonewall, Man., (J. B. Wallis); Edmonton, Alta., April 8, 1916, (F. S. Carr); N.A. species of *Coelambus*, published by J. D. Sherman, New York, 1919.

* *Coelambus hudsonicus* Fall. Ungava Bay, H.B.T., (L. M. Turner); N.A. species of Coelambus published by J. D. Sherman, New York, 1919.

Coelambus punctilineatus Fall. Stony Mountain, Man., April 13, 1912, (J. B. Wallis).

1441. *Agabus lecontei* Cr. Peachland, B.C., Aug. 7, 1919, (W. R. Metcalfe and J. B. Wallis).

Silphidæ.

* *Colon elongatum* Notman. Cochrane, Ont., Aug., 1918, (Howard Notman); Jour. N.Y. Ent. Soc., XXVII, 98.

Pselaphidæ.

1899. *Batrisus fontalis* Lec. Aweme, Man., April 18, 1919; in swarm of ants, (*Acanthomyops*), (S. Criddle).

Staphylinidæ.

Atheta (*Acrostoma*) *blanchardi* Ful. Stonewall, Man., July 18, 1918, in rotten fungus, (J. B. Wallis).

Atheta comitata Csy. Stonewall, Man., Aug. 18, 1918, in fungus. (J. B. Wallis). New to Manitoba.

Atheta (*Datomicra*) *celata* Er. Onah, Man., July 13, 1918; in larch swamp. (J. B. Wallis). New to Manitoba.

Atheta (*Demetrota*) *subrugosa* Kiew. Onah, Man., July 12, 1918, in moss. (J. B. Wallis). New to Manitoba.

Aleochara (*Polychara*) *deflecta* Say. Stonewall, Man., Aug. 18, 1918, (J. B. Wallis). New to Manitoba.

Aleochara (Euryodma) pleuralis Csy. Treesbank, Man., July 18, 1918, (J. B. Wallis). New to Manitoba.

Silusa modica Csy. Stonewall, Man., in rotten fungus, (J. B. Wallis). New to Manitoba.

Anomognathus cuspidata Er. Winnipeg, Man., Aug. 27, 1918; under bark of rotten *Negundo*, (J. B. Wallis). New to Manitoba. Apparently introduced from Europe, (A.F.).

Homalota plana Gyll. Winnipeg, Man., July 30-Aug. 14, 1918; under bark of rotten *Negundo*, (J. B. Wallis). New to Manitoba. Apparently introduced from Europe, (A.F.).

Gnypeta manitobæ Csy. Stonewall, Man., Aug. 18, 1918, (J. B. Wallis).

Gyrophaena nana Payk. Winnipeg, Man., Aug. 27, 1918, in fungus, (J. B. Wallis). New to Manitoba.

Gyrophaena pulchella Heer. Stonewall, Man., Aug. 18, 1918; Winnipeg, Man., Aug. 27, 1918; in fresh whitish fungi, among the gills. (J. B. Wallis). Apparently an introduction from Europe, (A.F.). New to Manitoba.

* *Lathrobium tenebrosum* Notman. Cochrane, Ont., Aug., 1918, (Howard Notman); Jour. N.Y. Ent. Soc., XXVII, 99.

* *Lathrobium humile* Notman. Cochrane, Ont., Aug., 1918, (Howard Notman); Jour. N.Y. Ent. Soc., XXVII, 100.

* *Scopæus linearis* Notman. Cochrane, Ont., Aug., 1918, (Howard Notman); Jour. N.Y. Ent. Soc., XXVII, 100.

Endomychidæ.

3180. *Phymaphora californica* Horn. Duncan, B.C., (A. W. Hanham).

Erotylidæ.

3239. *Tritoma flavicollis* Lec. Duncan, B.C., (A. W. Hanham).

Colydiidæ.

3271. *Lasconotus pusillus* Lec. Aweme, Man., Onah, Man., July, 1919, (N. Criddle).

Histeridæ.

* *Saprinus rugosifrons* Fall. Aweme, Man., (N. Criddle); Can. Ent., LI, 213.

* *Saprinus castanipennis* Fall. Aweme, Man., June 21, 1918, (N. Criddle); Can. Ent., LI, 214.

* *Saprinus iris* Fall. Aweme, Man., May 31, 1909, July 1, 1915, (N. Criddle); Can. Ent., LI, 214.

Nitidulidæ.

3713. *Epuræa aestiva* Linn. Aweme, Man., 1919, (N. Criddle).

* *Epuræa ornatula* Notman. Cochrane, Ont., Aug., 1918, (H. Notman); Jour. N.Y. Ent. Soc., XXVII, 102.

Dascyllidæ.

3991. *Eucinetus punctulatus* Lec. Stonewall, Man., Aug. 18, 1918; in rotten fungus, (J. B. Wallis).

Elateridæ.

4390. *Anthous cucullatus* Say. Husavick, Man., July 27, 1912, (J. B. Wallis). New to Manitoba.

4403. *Anthous vittiger* Lec. Winnipeg, Man., (J. B. Wallis). New to Manitoba.

Ptinidæ.

Ptilinus lobatus Csy. Aweme, Man., June 24, 1919, (N. Criddle); Husavick, Man., July 6, 1917, (L. H. D. Roberts). New to Manitoba.

5359. *Dinoderus substriatus* Payk. Mile 214, H.B.R., Man., Winnipeg, Man., June, July; Peachland, B.C., (J. B. Wallis).

Cisidæ.

* *Dolichocis manitoba* Dury. Aweme, Man., Oct., 1918, (N. and T. Criddle); Can. Ent., LI, 158.

* *Cis criddlei* Dury. Aweme, Man., Oct., 1915-1918, (E. and N. Criddle); Can. Ent., LI, 158.

Scarabæidæ.

5426. *Canthon ebenus* Say. Lyleton, Man., Aug. 27, 1919; Boissevain, Man., (N. Criddle).

5551. *Aphodius haldemani* Horn. Rosebank, Man., Aug. 10, 1917, (J. B. Wallis). New to Manitoba.

* *Serica cucullata* Dawson. Montreal, Que., May 6, 1905, (A. F. Winn); Ottawa, Ont.; Winnipeg, Man., (J. B. Wallis); Aweme, Man., (N. Criddle); Kentville, N.S.; British Columbia; Jour. N.Y. Ent. Soc., XXVII, 34.

Cerambycidæ.

* *Callidium subopacum* Sw. South of Rampart House, Y.T., (D. H. Nelles); Rep. Can. Arctic Exp., 1913-1918, Part E, Coleoptera, p. 12.

6250. *Pachyta rugipennis* Newm. Winnipeg, Man., May 18, 1919, (L. H. D. Roberts). New to Manitoba.

6385. *Monohammus minor* Lec. Winnipeg, Man., July 15, 1918, (J. B. Wallis). New to Manitoba.

Chrysomelidæ.

6558. *Syneta carinata* Mann. Mt. Prevost, near Duncan, B.C., 2,500 feet, (A. W. Hanham).

6721. *Xanthonia villosula* Melsh. Bird's Hill, Man., Sept. 23, 1917, (J. B. Wallis). New to Manitoba.

10407. *Monoxia debilis* Lec. Melita, Man., July 1, 1919; collected on *Grindelia squarrosa*, (N. Criddle).

7001a. *Systena ligata* Lec. Husavick, Man., Aug. 3, 1914, on Canada thistle; Winnipeg, Man., Aug. 14, 1918, (J. B. Wallis). New to Manitoba.

Tenebrionidæ.

7528. *Scaphidema aenolum* Lec. Stonewall, Man., Aug. 7, 1918; under bark of dead aspen, (J. B. Wallis).

Melandryidæ.

7656. *Phryganophilus collaris* Lec. Duncan, B.C., (A. W. Hanham).

7695. *Canifa pallipes* Melsh. Winnipeg, Man., May 28, 1911; Victoria Beach, Man., July 1, 1918; Miami, Man., June 27, 1916; Aweme, Man., July 15, 1918, (J. B. Wallis).

Œdemeridæ.

7733. *Nacerdes melanura* Linn. Vancouver, B.C., July 15, 1919, (A. W. Hanham).

Meloidæ.

8025. *Nemognatha apicalis* Lec. Lillooet, B.C., July 13, (A. W. Hanham).

Curculionidæ.

* *Trichalophus stefanssoni* Leng. Bernard Harbour, N.W.T., Sept. 26, 1914; May 22, July 6, 7, 1915; June, July and Sept., 1916, (F. Johansen); Cape Krusenstern, N.W.T., July, 1916, (D. Jenness); Kogluktualuk river, Coronation Gulf, N.W.T., July, 1915, (J. J. O'Neill); Langton Bay, N.W.T., 1911, (V. Stefansson); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part E, Coleoptera, p. 20.

8381. *Apion pennsylvanicum* Boh. Magnus, Man., Sept. 2, 1917, (J. B. Wallis).
Apion commodum Fall. Stony Mountain, Man., Aug. 8, 1918, on *Psoralea esculenta,* (J. B. Wallis).
Apion finitimum Fall. Magnus, Man., Sept. 2, 1917, (J. B. Wallis).
Apion nasutum Fall. Onah, Man., July 12, 1918, (J. B. Wallis). New to Canada.

10823. *Macrops ulkei* Dietz. Aweme, Man., May 7, 1919, (N. Criddle).

8576. *Tanysphyrus lemnæ* Fab. Miami, Man., June 27, 1916; Treesbank, Man., July 18, 1918, (J. B. Wallis). New to Manitoba.

8619. *Magdalis subtincta* Lec. St. Norbert, Man., June 24, 1917; Aweme, Man., July 15, 1918, (J. B. Wallis).

8620. *Magdalis hispoides* Lec. Onah, Man., July 8-12, 1918, (J. B. Wallis). New to Manitoba.

8627. *Magdalis alutacea* Lec. Victoria Beach, Man., July 1, 1918, (J. B. Wallis). New to Canada.

10958. *Promecotarsus densus* Csy. Aweme, Man., July 15, 1918, (J. B. Wallis). New to Manitoba.

8669. *Anthonomus canus* Lec. Onah, Man., July 13, 1918, (J. B. Wallis). New to Manitoba.
Ceutorhynchus solitarius Fall. St. Norbert, Man., June 24, 1917, (J. B. Wallis). New to Manitoba.

Calandridæ.

Sphenophorus aequalis. Stonewall, Man., July 5, 1918, (J. B. Wallis). New to Manitoba.

Ipidæ.

* *Dendroctonus johanseni* Sw. Sandstone rapids, Coppermine river, N.W.T., Feb., 1915, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part E, Coleoptera, p. 5.

* *Carphoborus andersoni* Sw. Sandstone rapids, Coppermine river, N.W.T., Feb. 15, 1915, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part E, Coleoptera, p. 6.

Diptera.

(Arranged according to a catalogue of North American Diptera, by J. M. Aldrich, Smithsonian Misc. Coll. XLVI, No. 1,444. The numbers refer to the pages in the catalogue.)

Tipulidæ.

* *Dicranomyia alascaensis* Alex. Nome, Alaska, Aug. 24, 25, 1916. (F. Johansen); Rep. Can. Arctic Exp., 1913-18, Vol. III, Part C, Diptera, p. 5.

80. *Limnobia sciophila* O.S. Lillooet, B.C., June 21, 1917, (M. H. Ruhmann); Gordon Head, B.C., April 30, 1918, (W. Downes).
81. *Limnobia solitaria* O.S. Lillooet, B.C., June 25, 1919, (M. H. Ruhmann).
97. *Xiphura topazina* O.S. Vineland, Ont., May 5, 1915, (W. A. Ross).
* *Nephrotoma arcticola* Alex. Bernard Harbour, N.W.T., July 1-14, 1916; July-Aug., 1915, (F. Johansen); Rep. Can. Arctic Exp., 1913-18, Vol. III, Part C, Diptera, p. 10.
98. *Nephrotoma ferruginea* Fab. Bowmanville, Ont., June, 1913, (W. A. Ross).
* *Nephrotoma euceroides* Alex. Perth, N.B., June 15, 1915, (F. M. McKenzie); Can. Ent., LI, 172.
* *Erioptera angustipennis* Alex. Bernard Harbour, Dolphin and Union Strait, N.W.T., Aug. 1-7, 1915, (F. Johansen); Rep. Can. Arctic Exp., 1913-18, Vol. III, Part C, Diptera, p. 5.
* *Tipula nebulipennis* Alex. Battle Harbour, Labrador, Aug. 1, 1912, (G. P. Engelhardt); Can. Ent., LI, 170.
* *Tipula trypetophora* Dietz. Victoria, B.C., July 6, 1912; An. Ent. Soc. Amer., XII, 89.
* *Tipula johanseni* Alex. Bernard Harbour, N.W.T., July 10, 1916, (F. Johansen); Rep. Can. Arctic Exp., 1913-18, Part C, Diptera, p. 11.
* *Tipula diflava* Alex. Bernard Harbour, N.W.T., July 12, 1915; Herschel Island, Y.T., July, 1916, (F. Johansen); Rep. Can. Arctic Exp., 1913-18, Part C, Diptera, p. 12.
* *Tipula hewitti* Alex. Bernard Harbour, N.W.T., July 1-14, 1916, (F. Johansen); Rep. Can. Arctic Exp., 1913-18, Part C, Diptera, p. 14.
* *Tipula subpolaris* Alex. Bernard Harbour, N.W.T., July-Aug., (F. Johansen); Rep. Can. Arctic Exp., 1913-18, Part C, Diptera, p. 14.
* *Tipula besselsoides* Alex. Bernard Harbour, N.W.T., July 1-14, 1916, (F. Johansen); Rep. Can. Arctic Exp., 1913-18, Part C, Diptera, p. 15.
* *Tipula subarctica* Alex. W. of Kongenevik, Camden bay, Alaska, July 4, 1914, (F. Johansen); Rep. Can. Arctic Exp., Part C, Diptera, p. 15.
* *Tricyphona frigida* Alex. Ketchikan, Alaska, Sept. 10, 1916, (F. Johansen); Rep. Can. Arctic Exp., 1913-18, Vol. III, Part C, Diptera, p. 7.
* *Tricyphona brevifurcata* Alex. W. of Konganevik, Camden bay, Alaska, July 4, 1914, (F. Johansen); Rep. Can. Arctic Exp., 1913-18, Vol. III, Part C, Diptera, p. 6.
* *Limnophila rhicnoptiloides* Alex. Bernard Harbour, N.W.T., July 15, 1915, (F. Johansen); Rep. Can. Arctic Exp., 1913-18, Vol. III, Part C, Diptera, p. 6.
* *Stygeropis parrioides* Alex. W. of Konganevik, Camden bay, Alaska, June 1914, (F. Johansen); Rep. Can. Arctic Exp., 1913-18, Vol. III, Part C, Diptera, p. 9.
100. *Tipula angustipennis* Loew. Vernon, B.C., April 2, 1915, (M. H. Ruhmann).
101. *Tipula cognata* Doane. Vernon, B.C., April 2, 1915, (M. H. Ruhmann).
102. *Tipula dorsolineata* Doane. Vernon, B.C., (M. H. Ruhmann); Victoria, B.C., (W. Downes).
102. *Tipula eluta* Loew. Vineland, Ont., Aug. 18, 1914, (W. A. Ross).
* *Tipula noveboracensis* Alex. Beaver Dam, N.B., June 23, 1914, (J. D. Tothill); Can. Ent., LI, 167.

Chironomidæ.

* *Tanypus alaskensis* Mall.; Rep. Can. Arctic Exp., 1913-18, Part C, Diptera, p. 35.

* *Diamesa arctica* Mall. Colville Mts., Wollaston peninsula, Victoria Island, July 22-29, 1915, (D. Jenness). Angmaloktok, Colville mountains, Wollaston peninsula, Victoria Island, July 29, 1915, (D. Jenness); Rep. Can. Arctic Exp., 1913-18, Part C, Diptera, p. 37.

Culicidæ.

* *Ædes pionips* Dyar. White River, Ont., June 17-25, 1918; Prince Albert, Sask., Aug. 14-18, 1918; Red Deer, Alta., July 30-Aug. 3, 1918; Nepigon, Ont., June 26, 1918; Lochearn, Alta, Aug. 5-7, 1918; Lamoral, Alta., Aug. 6, 1918; Lake Louise, Alta., July 11-17, 1918, (H. G. Dyar); White River, Ont., June 24, 1907, (Knab); Kenogami river, Ont., June 30, 1903, (W. J. Wilson); Insecutor Inscitiæ Menstruus, VII, 19.

* *Ædes intrudens* Dyar. White River, Ont., June 12-25, 1918; Nepigon, Ont., June 26, 1918; Dryden, Ont., June 29-30, 1918; Winnipeg Beach, Man., July, 1918; Lake Minnewanka, Alta, July 22, 1918; Banff, Alta., July 7-25, 1918; Laggan, Alta, July 11, 1918, (H. G. Dyar). With the description the following statement appears: "Eastern records are found in the monograph under *impiger* (page 757). They are correct, except that 'Ottawa, Ontario (J. Fletcher)' should be transferred to *lazarensis*;" Insecutor Inscitiæ Menstruus, VII, 24.

* *Ædes nearcticus* Dyar. Bernard Harbour, N.W.T., July 9, 1915; June 21-July 1, 1916, (F. Johansen); Collinson Point, Alaska, June 23, 1914, (F. Johansen); Rep. Can. Arctic Exp., 1913-18, Part C, Diptera, p. 32.

Bibionidæ.

166. *Bibio nervosus* Loew. Vernon, B.C., (M. H. Ruhmann); Saanich, B.C., (W. Downes).

Simuliidæ.

* *Simulium similis* Mall. Hood river, Arctic sound, N.W.T., Aug. 28, 1915, (R. M. Anderson); Bathurst inlet, N.W.T., Sept 1, 1915, (R. M. Anderson); Rep. Can. Arctic Exp., 1913-18; Vol. III, Part C, Diptera, p. 42.

* *Prosimulium borealis* Mall. Wollaston peninsula, Victoria island, 1915, (D. Jenness); Rep. Can. Arctic Exp., 1913-18, Vol. III, Part C, Diptera, p. 41.

Stratiomyidæ.

179. *Sargus decorus* Say. Lillooet, B.C., June 20, 1917; (M. H. Ruhmann).

180. *Sargus viridis* Say. Kelowna, B.C., June 18, 1918, (R. C. Treherne).

182. *Stratiomyia discalis* Loew. Vernon, B.C., May 17, 1917, (M. H. Ruhmann).

183. *Stratiomyia norma* Wied. Kelowna, B.C., June 26, 1918, (R. C. Treherne).

183. *Stratiomyia meigenii* Wied. Vernon, B.C., June 21, 1917, (R. C. Treherne).

183. *Stratiomyia maculosa* Loew. Lillooet, B.C., June 25, 1917, (M. H. Ruhmann).

189. *Nemotelus aratar* Mel. Walhachin, B.C., July 11, 1918, (E. R. Buckell).

Tabanidæ.

195. *Chrysops obsoletus* Wied. Vineland, Ont., June 20, 1919, (W. A. Ross).

201. *Tabanus insuetus* O.S. Vernon, B.C., April 15, 1915, (M. H. Ruhmann).

205. *Tabanus maculifer* Bigot. Lillooet, B.C., July 24, 1917, (R. C. Theherne).
206. *Tabanus procyon* O.S. Vernon, B.C., June 8, 1918, (R. C. Treherne).
207. *Tabanus rhombicus* O.S. Vernon, B.C., April 15, 1915, (M. H. Ruhmann).
208. *Tabanus stygius* Say. Vineland, Ont., July 8, 1919, (C. H. Curran).

Bombyliidæ.

231. *Anthrax hypomelas* Macq. Penticton, B.C., (R. C. Treherne); Walhachin, B.C., (E. R. Buckell).
234. *Anthrax sinuosa* Wied. Lillooet, B.C., July 23, 1917, (R. C. Treherne).
236. *Bombylius lancifer* O.S. Lillooet, B.C., Oyama, B.C., (M. H. Ruhmann).
* *Villa webberi* Jhn. Montreal, Que., June 11, (G. Chagnon), Ottawa, Ont., June 14, (Bro. Germain); Psyche, XXVI, 11.
* *Ploas atratula* Loew. Goldstream, B.C., June 2, 1918, (W. Downes).

Therevidæ.

247. *Psilocephala lævigata* Loew. Walhachin, B.C., July 11, 1918, (E. R. Buckell).
248. *Thereva egressa* Coq. Vernon, B.C., June 10, 1918, (R. C. Treherne).

Asilidæ.

256. *Stenopogon californiæ* Wlk. Vernon, B.C., July 8, 1918, (R. C. Treherne).
259. *Cyrtopogon callipedilus* Loew. Vernon, B.C., May 5, 1915, (M. H. Ruhmann).
260. *Cyrtopogon longimanus* Loew. Lillooet, B.C., July 16, 1917, (M. H. Ruhmann.
271. *Laphria pubescens* Will. Duncan, B.C., July 28, 1918, (W. Downes).
* *Erax harveyi* Hine. Vernon, B.C., Aug. 11-15, 1904, (R. V. Harvey); An. Ent. Soc. Amer., XII, 115.

Dolichopodidæ.

* *Medeterus frontalis* Van Duzee. Joliette, Que., July 13, (J. Ouillet); Proc. Cal. Acad. Sci., Aug., 1919, p. 266.
* *Medeterus vittatus* Van. Duzee. Kearney, Ont., July 26; Toronto, Ont., Sept. 2; Niagara Falls, Ont., July 20, (M. C. Van Duzee); Proc. Cal. Acad. Sci., Aug., 1919, p. 268.
* *Hydrophorus pilitarsis* Mall. Teller, Alaska, July 29, 1913; Aug. 6, 1913. (F. Johansen); Rep. Can. Arctic Exp., 1913-18, Vol. III, Part C, Diptera, p. 51.
303. *Dolichopus pachynemus* Loew. Outremont, Que., June 20, (J. Ouillett); Chatham, Ont., June 17, 1915. (M. C. Van Duzee). Addition to Quebec list.
* *Dolichopus dasyops* Mall. Bernard Harbour, N.W.T., July 10, 1916, (F. Johansen); Rep. Can. Arctic Exp., 1913-18, Vol. III, Part C, Diptera, p. 49.
309. *Pelastoneurus laetus* Loew. St. Louis, Que., Aug. 14, (J. Ouillet). Addition to Quebec list.

Empidæ.

* *Rhamphomyia erinacioides* Mall. W. of Konganevik, Camden bay, Alaska, July 4, 1914, (F. Johansen); Barter island, Arctic coast of Alaska, July 11, 1914, (D. Jenness); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 45.

* *Rhamphomyia ursina* Mall. Bernard Harbour, N.W.T., July 19, 1915, (F. Jonhansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 46.

* *Rhamphomyia similata* Mall. Bernard Harbour, N.W.T., July 18, 1915, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 46.

* *Rhamphomyia herschelli* Mall. Herschel island, Y.T., July 29, 1916, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 47.

* *Rhamphomyia conservativa* Mall. W. of Bernard Harbour, N.W.T., July 14, 1916; Herschel Is., Y.T., July 29, 1916; Bernard Harbour, N.W.T., July 10, 18, 19, and Aug. 1-7, 1915; Young Point, N.W.T., July 18, 1916, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 48.

Lonchopteridæ.

333. *Lonchoptera lutea* Panz. Vernon, B.C., Aug. 31, 1917, (M. H. Ruhmann).

Phoridæ.

* *Aphiochaeta platychira* Mall. Nome, Alaska, Aug. 21, 24, 25, 1916, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 52.

* *Aphiochaeta alaskensis* Mall. Nome, Alaska, Aug. 24, 25, 1916, (F. Johansen). Rep. Can. Arctic Exp. 1913-1918, Vol. III, Part C, Diptera, p. 52.

Syrphidæ.

350. *Pipiza fraudulenta* Loew. Vineland, Ont., June 8, 1919, (C. H. Curran).

354. *Myiolepta strigilata* Loew. Vineland, Ont., June 10, 1919, (C. H. Curran).

354. *Myiolepta nigra* Loew. Vineland, Ont., June 16, 1919, (C. H. Curran).

362. *Didea fasciata fuscipes* Loew. Lillooet, B.C., July 24, 1917, (R. C. Treherne); Vineland, Ont., June 6, Sept. 20, 1919, (C. H. Curran).

366. *Syrphus genualis* Will. Walhachin, B.C., July 30, 1918, (E. R. Buckell).
Syrphus knabi Shan. Vineland, Ont., Sept. 9, 1919, (C. H. Curran).

* *Syrphus sodalis interruptus* Mall. W. of Kongenevik, Camden Bay, Alaska, July 4, 1914, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 55.

368. *Syrphus xanthostoma* Will. Vernon, B.C., May 13, 1917, (M. H. Ruhmann).

370. *Mesogramma boscii* Macq. Saanich, B.C., May 10, 1918, (W. Downes).

371. *Mesogramma geminata* Say. Saanich, B.C., June 10, 1918, (W. Downes).

384. *Eristalis aeneus* Fab. Vineland, Ont., July 3-9, 1919, (C. H. Curran). First record we have for Canada.

387. *Eristalis inornatus* Loew. Vernon, B.C., May 31, 1917, (M. H. Ruhmann).

392. *Helophilus chrysostoma* Wied. Kelowna, B.C., June 26, 1918, (R. C. Treherne).

393. *Helophilus lactus* Loew. Vineland, Ont., June 4, July 7, 1919, (C. H. Curran).

394. *Asemosyrphus mexicanus* Macq. Kelowna, B.C., July 9, 1918, (R. C. Treherne).
Eumerus strigatus Fall. Aweme, Man., May 17, 1919, (N. Criddle); Vineland, Ont., June-Sept., (C. H. Curran).

398. *Xylota flavitibia* Bigot. Vernon, B.C., Aug. 10, 1915, (M. H. Ruhmann).
402. *Criorhina analis* Macq. Vineland, Ont., June 10, 1919, (C. H. Curran).
404. *Spilomyia longicornis* Loew. London, Ont., Aug. 25; Vineland, Ont., Sept. 8, 1919, (C. H. Curran).

Conopidæ.

412. *Myopa clausa* Loew. Kelowna, B.C., May 17, 1917, (M. H. Ruhmann).
413. *Myopia vicaria* Walk. Nelson, B.C., April 29, 1918, (R. C. Treherne).

Oestridæ.

419. *Cuterebra tenebrosa* Coq. Vernon, B.C., July, 1916, (M. H. Ruhmann).

Tachinidæ.

423. *Phorantha occidentis* Walk. Walhachin, B.C., July 16, 1918, (E. R. Buckell).
447. *Senotainia rubriventris* Macq. Vernon, B.C., (M. H. Ruhmann); Walhachin, B.C., July, (E. R. Buckell).
448. *Senotainia trilineata* Van der Wulp. Walhachin, B.C., July, (E. R. Buckell); Vernon, B.C., (M. H. Ruhmann).
* *Peleteria arctica* Mall. Cockburn Point, N.W.T., Sept. 5, 1914, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 57.

Sarcophagidæ.

* *Meloposarcophaga tothilli* Parker. British Columbia, Savary Island, June 13-31, 1917, (R. S. Sherman); Can. Ent. LI., 155.
Sarcophaga communis Park. Walhachin, B.C., (E. R. Buckell).
512. *Sarcophaga helicis* Towns. Kelowna, B.C., June 13, 1918, (R. C. Treherne).
Sarcophaga planifrons Ald. Walhachin, B.C., (E. R. Buckell).

Muscidæ.

* *Phormia caerulea* Mall. Bernard Harbour, N.W.T., May 24, 1915; June-July, 1915-1916, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 58.
Pyrellia cyanicolor Zett. Vernon, B.C., May 30, 1917, (M. H. Ruhmann).

Anthomyidæ.

* *Phaonia imitatrix* Mall. Bernard Harbour, N.W.T., July, 1916, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 61.
* *Phaonia minima* Mall. Nome, Alaska, Aug. 21, 24, 25, 1916, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 61.
* *Mydaeina obscura* Mall. Bernard Harbour, N.W.T., Aug. 4, 1915, June, 1916, (F. Johansen); Colville Mts., Wollaston Peninsula, Victoria Island, July 22, 1915, (D. Jenness); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C., Diptera, p. 62.
* *Aricia borealis* Mall. Bernard Harbour, N.W.T., July, 1916, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 64.
* *Alliopsis obesa* Mall. Bernard Harbour, N.W.T., June, 1915-16, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 70.

547. *Limnophora narona* Walk. Walhachin, B.C., July 17, 1918, (E. R. Buckell).

548. *Anthomyia albicincta* Fall. Vernon, B.C., Aug. 1, 1917, (M. H. Ruhmann).

* *Helina fletcheri* Mall. Radisson, Sask., July 30, 1907, (J. Fletcher); Can. Ent. LI. 274.

* *Helina tuberculata* Mall. Rigolet, Labrador, July 18, 1906; Can. Ent. LI. 277.

550. *Anthomyia pratincola* Panzer. Vernon, B.C., Aug. 1, 1917, (M. H. Ruhmann).

* *Hydrophoria arctica* Mall. Cockburn Point, Sept. 5, 1914, (F. Johansen); Bernard Harbour, N.W.T., June, 1915, (F. Johansen); Rep. Can. Arctic Exp. 1913-1918, Vol. III, Part C, Diptera, p. 69.

* *Hylemyia acrostichalis* Mall. Nome, Alaska, Aug. 21, 1916, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 72.

* *Hylemyia quintilis* Mall. Godbout, Que., July 25, 1918, (E. M. Walker); Can. Ent. LI. 274.

* *Hylemyia pedestris* Mall. Godbout, Que., July 25, 1918, (E. M. Walker); Can. Ent. LI. 274.

* *Hylemyia spinosissima* Mall. Port Hope, Ont., June 13, 1897, (W. R. Metcalfe); Can. Ent. LI. 95.

* *Phorbia brevitarsata* Mall. W. of Konganevik, Camden Bay, Alaska, June, July 4, 1914, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 73.

558. *Pegomyia ruficeps* Stein. Vernon, B.C., (R. C. Treherne).

* *Pogonomyia quadrisetosa* Mall. W. of Bernard Harbour, N.W.T., July 14, 1916, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 66.

* *Pogonomyioides atrata* Mall. Bernard Harbour, N.W.T., July 7, 1915, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 67.

* *Coenosia fuscifrons* Mall. Brockville, Ont., Aug. 12, 1903, (W. R. Metcalfe); Ottawa, Ont., Aug. 17, 1907, (J. Fletcher); Port Hope, Ont., May 14, 1897, (W. R. Metcalfe); Can. Ent. LI. 96.

563. *Schoenomyza chrysostoma* Loew. Vernon, B.C., Aug. 19, 1917, (M. H. Ruhmann).

Scatophagidæ.

* *Gonatherus atricornis* Mall. Bernard Harbour, N.W.T. and Cape Krusenstern, July 3, 1919, (F. Johansen); Rep. Can. Arctic Exp. 1913-1918, Vol. III, Part C, Diptera, p. 77.

* *Cordylurella subrittata* Mall. Bernard Harbour, N.W.T., July 18-19, 1915, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 78.

* *Dasypleuron tibialis* Mall. Collinson Point, Alaska, June 20, 1914, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 79.

* *Allomyia unguiculata* Mall. Chantry Island, Bernard Harbour, N.W.T., July 17, 1916, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 80.

Helomyzidæ.

* *Neoleria rotundicornis* Mall. Nome, Alaska, Aug. 24-25, 1916, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 83.

* *Oecothea aristata* Mall. Bernard Harbour, N.W.T., Aug. 1-7, 14, Sept., 1915; July 10, 1916, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 82.

573. *Tephrochlamys rufiventris* Mg. Vernon, B.C., April 12, 1915, (M. H. Ruhmann).

Borboridæ.

* *Leptocera transversalis* Mall. Collinson Point, Alaska, June 13, 1914, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 53.

Sciomyzidæ.

580. *Tetanocera plumosa* Loew. Lillooet, B.C.; Vernon, B.C., (M. H. Ruhmann).

Sapromyzidæ.

582. *Palloptera jucunda* Loew. Creston, B.C., Sept. 19, 1918, (R. C. Treherne).

Ortalidæ.

592. *Anacampta latiuscula* Loew. Vernon, B.C., (R. C. Treherne).

595. *Chrysomyza demandata* Fab. Vernon, B.C., July 5, 1918, (M. H. Ruhmann).

598. *Seoptera vibrans* Linn. Vernon, B.C., July 1, 1918, (R. C. Treherne).

Trypetidæ.

604. *Spilographa setosa* Doane. Vernon, B.C., July 17, 1919, (M. H. Ruhmann).

Piophilidæ.

* *Piophila borealis* Mall. W. of Konganevik, Camden Bay, Alaska, July 4, 1914, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part C, Diptera, p. 84.

Hymenoptera.

The following new species of saw-flies appear in the Report of the Canadian Arctic Expedition, 1913-1918, issued Nov. 3, 1919, Vol. III, Part G.

Tenthredinoidea.

* *Rhogogastera reliqua* MacG. Nome, Alaska, Aug. 21-25, 1916, (F. Johansen).

* *Euura abortiva* MacG. Herschel Island, Y.T., adults from galls on leaves of *Salix reticulata* L., July, 1915, (F. Johansen).

* *Euura arctica* MacG. Bernard Harbour and Cape Krusenstern, N.W.T, July 6, 1916, (F. Johansen).

* *Pontania atrata* MacG. Herschel Island, Y.T., July, 1915, (F. Johansen).

* *Pontania lorata* MacG. Herschel Island, Y.T., adults from galls on *Salix arctica*, July, 1915, (F. Johansen).

* *Pontania delicatula* MacG. Herschel Island, Y.T., adults from galls on leaves of *Salix reticulata*, July, 1915, (F. Johansen).

* *Pontania deminuta* MacG. Bernard Harbour, N.W.T., Aug. 16, 1915, (F. Johansen).

* *Pontania quadrifasciata* MacG. Sandstone Rapids, Coppermine River, N.W.T., July, 1915, (F. Johansen).

* *Pontania subpallida* MacG. Bernard Harbour, N.W.T., July 12, 1915, (F. Johansen).

* *Pontania trifasciata* MacG. Bernard Harbour, N.W.T., July 15, 1915 (F. Johansen).

* *Amauronematus completus* MacG. Collinson Point, Alaska, June 20, 1914, (F. Johansen).

* *Amauronematus indicatus* MacG. West of Konganevik, Camden Bay, Alaska, July 4, 1914, (F. Johansen).

* *Amauronematus digestus* MacG. West of Konganevik, Camden Bay, Alaska, July 4, 1914, (F. Johansen).

* *Amauronematus cogitatus* MacG. Demarcation Point, Alaska, June 23, 1914, (F. Johansen).

* *Amauronematus varianus* MacG. West of Konganevik, Camden Bay, Alaska, June 27, 1914, (F. Johansen).

* *Amauronematus aulatus* MacG. Barter Island, Alaskan Arctic Coast, June 16, 1914, (D. Jenness).

* *Amauronematus magnus* MacG. Bernard Harbour, N.W.T., July 15, 1915, (F. Johansen).

Braconidæ.

* *Opius downesi* Gahan. Victoria, B.C., host *Rhagoletis pomonella* (W. Downes); Proc. Ent. Soc. Wash., XXI, 164.

Ichneumonidæ.

* *Dioctes modestus* Brues. Bernard Harbour, N.W.T., Aug. 7, 12, 1915, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part G, p. 23.

* *Polyblastus arcticus* Brues. Ketchikan, Southern Alaska, Sept. 10, 1914, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part G, p. 22.

* *Aptesis nivarius* Brues. Collinson Point, Alaska, June 20, 1914, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part G, Hymenoptera, p. 21.

Formicidæ.

Solenopsis molesta Say. Found generally at points south of Penticton in Okanagan Valley, B.C., June, 1919, (R. C. Treherne and E. R. Buckell).

Tapinoma sessile Say. Found generally at points south of Penticton, in Okanagan Valley, B.C., June, 1919, (R. C. Treherne and E. R. Buckell).

Pogonomyrmex occidentalis Cresson. Found in Lower Okanagan, B.C., fairly common at points south of Fairview, but not common at points north of Fairview. Also found at Summerland, B.C., (R. C. Treherne and E. R. Buckell. Determined by Dr. W. M. Wheeler, who reported "first record of any species of *Pogonomyrmex* from British America."

Formica subpolita Mayr. var. *camponoticeps* Wheeler. Found at points south of Penticton, in Lower Okanagan Valley, B.C., June, 1919, (R. C. Treherne and E. R. Buckell).

Formica fusca L. var. *argentea* Walker. Fairview, B.C., Vaseaux Lake, B.C., Rock Creek, B.C., Naramata, B.C., June, 1919, (R. C. Treherne and E. R. Buckell).

Formica sanguinea Latr. subsp. *subintegra* Emery. Fairview, B.C., Vaseaux Lake, B.C., June, 1919, (R. C. Treherne and E. R. Buckell).

Formica neogagates Em. Fairview, B.C., Okanagan Falls, B.C., Kaleden, B.C., Vaseaux Lake, B.C., June, 1919, (R. C. Treherne and E. R. Buckell).

Camponotus laevigatus F. Smith. Osoyoos, B.C., June, 1919, (R. C. Treherne and E. R. Buckell).

Psammocharidæ.

* *Pompiloides canadensis* Banks. Truro, N.S., Aug. 12, (R. Matheson); Val Morin, Que., July 29, 30, (J. Ouellet); Can. Ent. LI., 82.

Apidæ.

* *Bombus neoboreus* Sladen. Bernard Harbour, N.W.T., Aug 17, 18, 1915; July 10, 1916; June 6, 21, 25; July 2, 9, 30; Aug. 7, 8, 17, 18, 1915; June 16, July 3, 1916; July 19, Aug. 10, 14, 1915, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part G, p. 28.

Philanthidæ.

Philanthus (*Anthophilus*) *psyche* Dunn. Aweme, Man., August, 1914, (N. Criddle); Medicine Hat, Alta., July, August, 1917, (F. W. L. Sladen).

Philanthus (*Anthophilus*) *inversus* Patt. Medicine Hat, Alta., August, 1916, 1917, (F. W. L. Sladen). (What I believe to be the males of this rare species were taken by me at Medicine Hat, July, August, 1916, 1917 —F.W.L.S.).

Philanthus (*Pseuanthophilus*) *frontalis* Cr. Summerland, B.C., July, August, 1916, 1917; Medicine Hat, Alta., July, August, 1916, 1917, (F. W. L. Sladen).

Philanthus (*Anthophilus*) *multimaculatus* Cam. Vernon, Summerland, Keremeos, B.C., July, 1916, (F. W. L. Sladen).

Prosopidæ.

Prosopis ziziae Rob. Ottawa, June, 1913, (F. W. L. Sladen).

Prosopis modestus Say. Kaslo, B.C., June, July, 1906, (J. W. Cockle); Ottawa, June, July, August, 1913; Kazubazua, Que., August, 1913, (F. W. L. Sladen).

Prosopis elliptica Kirby. Kaslo, B.C., June, 1906, (J. W. Cockle);

Prosopis varifrons Cr. Ottawa, June, 1913, (F. W. L. Sladen).

Prosopis cressoni Ckll. Ottawa, June, July, August, 1913, (F. W. L. Sladen).

Colletidæ.

Colletes lacustris Swenk. Toronto, August, 1887, (W. Brodie); Ottawa, June, July, 1913, (F. W. L. Sladen).

Colletes brevicornis Rob. Aweme, Man., June, 1913, (N. Criddle).

Colletes compactus hesperius Swenk. Similkameen, Okanagan, B.C., Sept. 1913, (T. Wilson).

Colletes armatus Patton. Toronto, August, September, 1885, 1890, 1893, (W. Brodie); Rostrevor, Ont., September, 1907, (A. Gibson); Kazubazua, Que., August, 1913; Hull, Que., August, 1913, on *Solidago;* Ottawa, August, September, 1913, (F. W. L. Sladen).

Colletes fulgidus Swenk. Peachland, B.C., July, 1909, (J. B. Wallis).

Colletes americanus Cr. Toronto, August, 1885, (W. Brodie); Kazubazua, Que., August, September, 1913; Ottawa, October, 1913, (F. W. L. Sladen).

Colletes similis Rob. Aweme, Man., August, 1913, (N. Criddle).

Colletes hyalinus Prov. Toronto, July to September, 1882 to 1893, (W. Brodie); Ottawa, June, July, 1913; Kirk's Ferry, Que., July, 1913; Kazubazua, Que., July, 1913, (F. W. L. Sladen).

Colletes mesocopus Swenk. Toronto, June, July, August, 1887-1893; Port Sidney, Ont., June, 1897, (W. Brodie); Kazubazua, Que., July, 1913, (F. W. L. Sladen).

Colletes eulophi Rob. Toronto, June, July, August, 1885-1893, (W. Brodie); Ottawa, June, July, 1913; Kirk's Ferry, Que., July, 1913; Kazubazua, Que., July, 1913, (F. W. L. Sladen).

Colletes phaceliae Ckll. (*Salicicola geranii* Ckll.). Teulon, Man.; Pincher, Alta., July 10, 1904, (T. N. Willing).

Odonata.

Coenagrionidæ.

* *Enallagma vesperum* Calvert. Toronto, Ont., Aug. 16, 1907, (E. M. Walker); Trans. Amer. Ent. Soc., XLV, 380.

Hemiptera.

Cicadellidæ.

* *Euscelis hyperboreus* Van Duzee. West of Kongeñevik, Camden Bay, Alaska, June 27, 1914; Bernard Harbour, N.W.T., July 15, 1915, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part F, p. 4.

Neuropteroid Insects.

Psocidæ.

Atropos pulsatoria Linn. Montreal, Que., Sept. 24, 1919, (E. H. Strickland).

Perlidæ.

* *Capnia nearctica* Banks. Bernard Harbour, N.W.T., June 25, 1915, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part B, p. 3.

Trichoptera.

* *Analobia emarginata* Banks. Teller, Alaska, July 29, 1913, (F. Johansen). Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part B, p. 4.

Dermoptera.

Forficulidæ.

Forficula auricularia Linn. Vancouver, B.C., in house, (R. C. Treherne).

Orthoptera.

Acridiidæ.

Orphulella pelidna Burm. Fairview, B.C., Aug. 7, 1919, (E. R. Buckell). New to British Columbia.

Chloealtis abdominalis Brun. Salmon Arm, B.C., Sept. 29, 1919, (E. R. Buckell).

Xanthippus (*Hippiscus*) *vitellinus* Sauss. Fairview, B.C., (E. R. Buckell); Osoyoos, B.C., (W. B. Anderson).

Melanoplus cinereus Scud. Fairview, B.C., Aug. 7, 1919, (E. R. Buckell). New to Canada.

* *Asemoplus somesi* Hebard. Banff, Alta., (N. B. Sanson); Lake Louise, Alta, (Mrs. Schaeffer); Kitchener Glacier on Mt. Kokanee, B.C., (A. N. Caudell); Trans. Amer. Ent. Soc. XLV, 274.

Locustidæ.

Amblycorypha oblongifolia De. G. Pt. Pelee, Ont., Sept., 1905, (P. A. Taverner).

Collembola.

* *Achorutes sensilis* Folsom. Bernard Harbour, N.W.T., July 5, 1916, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part A, p. 5.

* *Onychiurus duodecimpunctatus* Folsom. Bernard Harbour, N.W.T., July 1915, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part A, p. 6.

* *Entomobrya comparata* Folsom. Bernard Harbour, N.W.T., May, 1915, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part A, p. 13.

Thysanoptera.

Apterothrips subreticulatus Bagnall. This species was described in the Trans. Nat. Hist. Soc. of Northumberland, Vol. III, pt. 1, p. 185. The type locality is Massett, Q.C.I., collected most probably by J. H. Keen. I have also taken the species at Lillooet, B.C., July, 1918. The type is in the British Museum, (R. C. Treherne).

* *Ælothrips auricestus* Treherne. Vernon, B.C., Kelowna, B.C., July, 1917, (R. C. Treherne); Can. Ent. LI., 184.

* *Euthrips cameroni* Bagnall. Seamans, Sask., Aug. 4, 1917, (A. E. Cameron); An. Mag. Nat. Hist. IV, ninth series, 271.

* *Frankliniella varicorne* Bagnall. Seamans, Sask., Aug. 4, 1917, (A. E. Cameron); An. Mag. Nat. Hist., IV, ninth series, 269.

Acarina.

Cheyletidæ.

Cheyletus eruditus (Schrank). Montreal, Que., Sept. 24, 1919, (E. H. Strickland). First Canadian record, (E.H.S.).

Tetranychidæ.

* *Stigmaeus arcticus* Banks. Bernard Harbour, N.W.T., June 18, 1915, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part H, p. 11.

Araneida.

(Arranged according to Bank's Catalogue of Nearctic Spiders, U.S.N.M., Bull. 72. The numbers refer to the pages in the catalogue.)

Clubionidæ.

14. *Clubiona riparia* Koch. Klondike Valley, Y.T., 1919, (W. E. Cockfield).

Linyphiidæ.

* *Microneta maritima* Emer. Cockburn Point, Dolphin and Union Strait, N.W.T., Sept., 1914, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part H, p. 4.

* *Tmeticus alatus* Emer. Cockburn Point, N.W.T., Sept. 26, 1914; Bernard Harbour, N.W.T., June 27, 1916, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part H, p. 3.

Tmeticus conicus Emer. Klondike Valley, Y.T., 1919, (W. E. Cockfield).

Epeiridæ.

41. *Epeira carbonaria* Koch. Klondike Valley, Y.T., 1919, (W. E. Cockfield).
42. *Epeira diadema* Clerck. St. John's, Nfld., (A. English).

Thomisidæ.

48. *Xysticus limbatus* Keys. Klondike Valley, Y.T., 1919, (W. E. Cockfield).
49. *Coriarachne brunneipes* Banks. Klondike Valley, Y.T., 1919, (W. E. Cockfield).
51. *Tibellus oblongus* Wal. Klondike Valley, Y.T., 1919, (W. E. Cockfield).
52. *Philodromus pacificus* Banks. Klondike Valley, Y.T., 1919, (W. E. Cockfield). First Canadian record.

Lycosidæ.

* *Lycosa asivak* Emer. Bernard Harbour, N.W.T., June to September; Camden Bay, Alaska, July 4, 1914, (F. Johansen); Rep. Can. Arctic Exp., 1913-1918, Vol. III, Part H, p. 5.

Pardosa albiceps Emer. Klondike Valley, Y. T., 1919, (W. E. Cockfield).

59. *Pardosa uncata* Thor. Klondike Valley, near Dawson, Y.T., 1919, (W. E. Cockfield).

INDEX